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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Care of Foundry Plant.

Probably the machine on which the greatest care is bestowed is the motor cycle belonging to a foreman fitter, because he obviously is proud of his machine. At the other end of the scale, the average foundry plant is often the dirtiest and most neglected, because for some reason or other nobody takes much interest in it. A number of factors are responsible for this, the most obvious being that of a filthy atmosphere. Additionally, there is the lack of interest displayed by the operator, sometimes associated with the fact that no fitter is directly attached to the foundry department. This state of affairs can be largely overcome by "presenting" a machine, a number of moulding boxes or a tool to a man so long as he remains in the shop. When he realises that the plant is his own he immediately begins to take a pride in its appearance, and it becomes a bright spot in the foundry. Anyone can demonstrate the importance of this psychological factor by smashing a tool belonging to workmen worth a couple of shillings, and in his presence one belonging to the management worth two pounds. The basic principle underlying this question is to allocate as far as possible as much plant to each individual, and to let the recipient know that it is his own temporary property. Material then lent to a fellow workman is done so with the proviso that "it's my property, so take care of it." Unfortunately, the division of the working day into two or three shifts militates against this system. Then, where possible, a mechanic should be introduced into the foundry, with the injunction that it is his department, and that it is up to him to keep it in running order. Too often, with the smaller jobbing foundries, this is left to one of the trimmers. We would advocate that where three moulders are each using forty of the same type of boxes, these should bear the name or mark of the individual, who should be responsible for their condition, not with the idea of checking who breaks the most, but simply to introduce that feeling of possession with which is associated care in handling.

This system of supplying individual requisites instead of allocating so many to the shop would certainly encumber those foundries which are cramped in area, but the method should be amplified by forming partnerships or limited ownership of the lesser-used plant. One of the largest foundries in the country has established the system of segregating the various trades and operations as far as possible, for (to quote the managing director) "it has been a common experience that where two sets of men of different trades were working in the same shop there was continual quarrelling as to who should have the use of the crane, etc." It is obvious, if a large works finds that it is a commercial axiom to sub-divide the men so as to form what amounts to a limited "ownership," surely for the smaller foundries it is sommonsense to allot, not only in the formal sense, but in the most intimate way possible, a tool or machine to each individual, and failing that to a group of the smallest economic dimensions.

Electric Furnaces for Various Uses.

The increased activity among the railroads and in the railroad supply field has been reflected in an increased demand for electric furnace equipment. The Electric Furnace Company, Salem, Ohio, has just taken an order for a 250-kw. car type Baily annealing furnace from a large western manufacturer of manganese steel castings for a Pacific Coast plant. The furnace will have a capacity to heat 17 tons of manganese castings per day. Another recent order is for a 125-kw. melting furnace for ferro-manganese which will be installed in the plant of the Pettibone-Mulliken Corporation, Chicago, and will be used for making hot additions to each charge of the Heroult electric furnaces. This Baily unit will have a capacity of 1,000 lbs. of ferro-manganese per hour. The Griffin Wheel Company placed an order for a 75-kw. melting furnace for melting bronze for railroad bearings. This furnace will have a hearth capacity of 1,000 lbs. and will be installed at Tacoma, Wash. The Best Foundry Company, Bedford, Ohio, has placed an order for a 50-kw. 800-lb. melting furnace for melting copper-zinc alloys.—"Iron Age."

THE ELECTRIC STEEL & METALS, LIMITED, plant at Welland, Ont., Canada, has been purchased by an American organisation.

Self-contained Electrically-driven Moulding Machine.

We have received from Messrs. Henry Wallwork & Company, Limited, Roger Street, Manchester, the following particulars of their self-contained electrically-driven moulding machine which embodies a number of interesting features.

The machine is the firm's well-known standard plain ram type, equipped with a main ram 10 in. dia., two lifting-cylinders, compressed-air vibrator, and cleaning nozzle. The machine will take a standard box either 18 in. or 21 in. long by 13 in. wide by 4 in. deep; the lift is 8 in. The air at a pressure of 70 lbs. per sq. in. is supplied by a self-contained electrically-driven air compressor with receiver fixed at the back of or conveniently near to the moulding machine, the supply being controlled by a two-way valve fixed at the front of the machine.

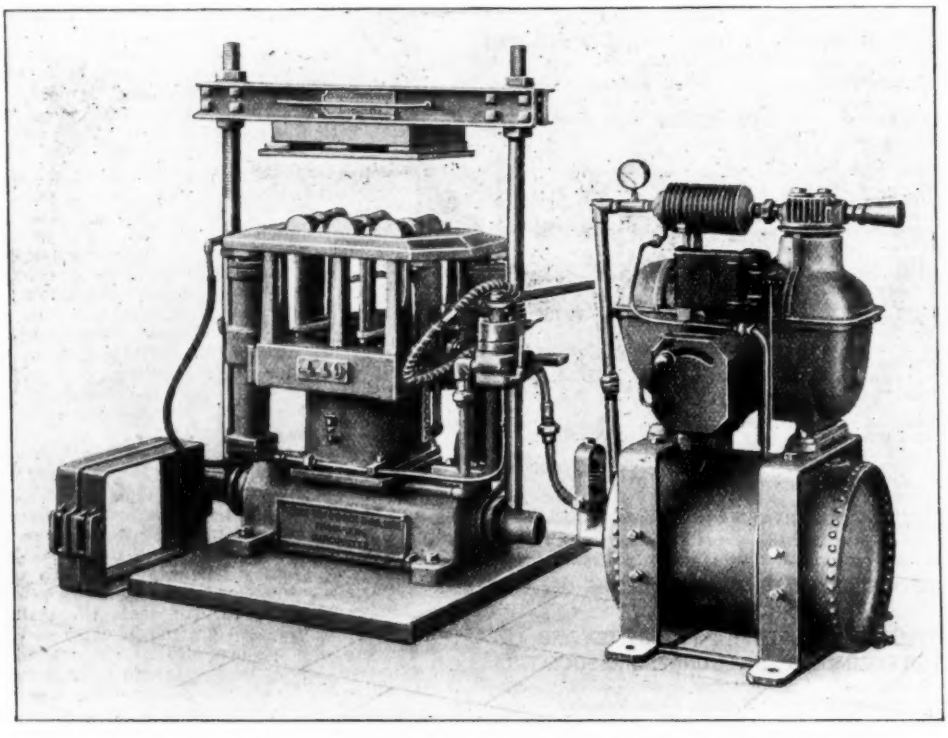


Fig. 1.—The Wallwork Self-contained Electrically-driven Moulding Machine.

Capacity.—The output obtainable is from 12 to 15 boxes per hour.

The motor, which is of 2 h.p., is designed and constructed specially for these machines with special fan cooling, and is supplied for 110 and 220 volt D.C., and for 110 and 220 volt A.C. as required. A removable cylinder-head on the compressor carries inlet and outlet valves, both of which are arranged for pipe connections, so that an inlet pipe may be used to bring clean air to the compressor, which leaves the factory fully lubricated and ready to run. There are no oil cups to refill nor any oil lever to maintain. Grease is fed to all bearings through felt wicks by capillary attraction. The gears are run in grease, and cylinder walls are also grease-lubricated by means of a felt lubricating-pad into which the piston is pressed slightly at the bottom of each stroke, and the occasional renewing of this grease is all that is necessary.

The housing of the machine presents unique features, as the motor gear-train and compressor are mounted as one unit. The top cover is in three sections, the removal of all of which exposes the entire mechanism.

Mr. A. Neilson, a prominent Coatbridge citizen, has died at his residence, Ardvohr, Dunbeth Avenue, Coatbridge, at the age of 64. Mr. Neilson, who was a native of New Monkland, was a partner in the firm of Messrs. William Martin, Sons & Company, Dundyvan Ironworks.

America Welcomes British Delegates.

By Cable.

Mr. Oliver Stubbs, the President of the Institution of British Foundrymen, and Mr. T. H. Firth, of the Brightside Foundry Company, of Sheffield, a past president of the Institution, were formally welcomed to the States at a dinner held on April 18 at the Astoria Hotel, New York, given under the auspices of the American Foundrymen's Association. The dinner was thoroughly representative, as it included many prominent officials of the American Foundrymen's Association and delegates from engineering and industrial societies. Amongst those present were Messrs. W. R. Bean (president of the American Foundrymen's Association); Stanley G. Flagg, of Philadelphia; Alfred E. Howell, of Sommerville, New Jersey; J. P. Pero, of Montreal, Canada; C. S. Koch, of McKeesport, Pa.; G. H. Clamer, of Philadelphia; V. E. Menich, of New York; H. R. Atwater, of Cleveland; A. B. Root, of Boston; C. B. Connelly, of Harrisburg, Pa.; C. E. Hoyt, of Chicago; A. D. Flynn, of New York; and Magnus W. Alexander, of Washington. Mr. Bean, who presided, called upon Mr. Flagg, the oldest past president of the American Association, to voice the greeting to the British delegates, which was responded to by Mr. Stubbs. Mr. Magnus W. Alexander then discussed industrial conditions throughout the world. The Cleveland manufacturers and the Pittsburgh foundrymen tendered complimentary dinners on April 21 and April 25 respectively.

Argentine Contracts.—The following contracts secured in public competition in Argentina are reported in German papers:—Gutehoffnungshütte, girders, etc., for a bridge over the Riachuelo (Pueyrredon Bridge); Harkort Company, girders for a bridge over Rio Quinto (Province of San Luiz); and the Gelsenkirchen Company, 7,150 tons of cast-iron pipes, for $307,849 (say £61,570) gold, for sanitary works in Buenos Aires and San Juan. In addition to this, the Krupp Company is building bridges over the Rio Toro and the Rio Blanco for the Transandine railway, Salto-Antofagasta, for which line the Krupp Company has supplied 30,000 tons of railway material in exchange for Argentine wool.

Cast Iron and its Chemical Composition.*

By O. Smalley.

Cupola-melted cast iron is a material of unknown thermal stability, a mechanical mixture of elements and compounds which only by careful manipulation can be arranged, within certain limits, to give physical properties that render it a reliable material of construction.

Because of its economic value, the metallurgist has long endeavoured to bring it into line with steel and other alloys whose physical properties are under reasonable control. Recent reports give the impression that our present lack of knowledge of the metallurgy of cast iron is a result of the scientist having concentrated his attentions elsewhere. To a certain extent this is true, because a knowledge of the constitution of a simple series of elements is essential to an understanding of a more complex series. At the same time, although cast iron belongs to the latter, it has been closely studied alongside with the simpler combination to which it is allied, viz., steel; and although a more comprehensive understanding of the physico-chemical properties of the iron-carbon and the iron-carbon-manganese combinations is possessed, it is only because they give rise to a series of true alloys, whilst the combination of elements known as "cast iron" does not.

Semi-Steel.

Recently a large and reputable manufacturer of refined cast iron submitted for inspection various selling samples of his products. Amongst these was one which had been forged down to a wedge shape, so prepared to demonstrate the quality of this iron for the manufacture of high-grade cylinder castings. On analysing, the following composition was obtained:—C.c., 0.64; Gr.c., 1.21; Si., 1.32; Mn., 1.32; P., 0.082; and S., 0.060, proving it to be nearer a steel than cast iron, and to have been made by an oxidising process from steel scrap, pig iron and ferro-silicon additions.

What advantage is to be gained by the use of this iron in the cupola? Is it superior to refined iron made in the cupola to the following composition:—Tc., 2.9; Si., 1.32; Mn., 1.32; P., 0.10; and S., 0.060, which, incidentally, can be prepared at one-third the cost? It may be argued that a refined cast iron cannot be prepared in the cupola from cast iron and steel scrap in that it will contain a high total carbon, may be oxygen or oxide or iron—a much-discussed bogey of to-day—and be high in sulphur. Yet surely this is the material which the engineer means when he specifies semi-steel. It can be nothing more or less than cast iron

FIG. 1.—HEMATITE SAND CAST.

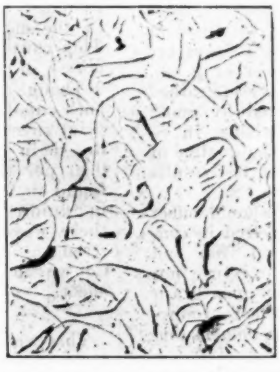


FIG. 2.—HEMATITE CAST IN 1 IN. SQ. BARS.

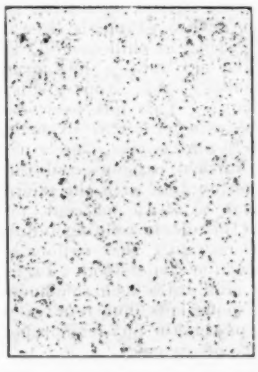


FIG. 3.—HEMATITE DIE CAST.

Moldenke speaks of cast iron as a "conglomeration of elements which is little understood." This aptly sums the position up with regard to our present knowledge of the constitution of cast iron. In all there are 18 to 20 different elements in cupola melted iron which, giving rise to the presence of compounds of widely different chemical and physical properties, possesses certain definite limitations.

A recognition of these limitations and a knowledge of the fundamental principles controlling the production of any particular combination of physical properties is the urgent need of to-day, not development as a competitor with steel.

Chemical Composition.

The amounts of the usual elements in cast iron vary as follows:—C., 2.8 to 3.9; Si., 0.8 to 5.0; Mn., 0.3 to 1.3; P., 0.10 to 1.80; and S., 0.05 to 0.20.

The chemical composition of cast iron is somewhat analogous to that of a moulding sand; it indicates the principal elements present, but it does not give any idea of the chemical or physical constitution of the compounds formed and their relation to one another, which factors control its utility. In other words, chemical composition is of little value without a knowledge of the metallurgy of cast iron. Unfortunately, the metallurgy of cast iron, as previously stated, is so complex that as yet it is far from being a science; in fact, so many problems require immediate elucidation to-day that a close co-operation of the metallurgist and foundryman is essential to the successful production of commercial iron castings.

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen.

melted with steel; it cannot be recognised from ordinary cast iron by chemical analysis.

Semi-steel is sometimes defined as low-carbon cast iron. This, however, is incorrect, there being little difference in the total carbon content of cast iron melted without steel and that melted with, say, up to 25 per cent. Nor is it safe to assert that steel is either detrimental or beneficial because of the oxygen introduced. If steel is melted with cast iron in a correctly-designed cupola, using a good hard coke, the correct volume of air, and is suitably fluxed, there is nothing to choose between semi-steel and cast iron so far as fluidity and the production of clean castings are concerned. The addition of steel, however, is beneficial in that it gives a closer-grained, tougher and better wearing iron, and improves the solidity of the casting as a whole. This is a conclusion proved by many years of practical experience.

This improvement is directly attributable to the quantity and form of the graphitic carbon present. It has nothing to do with oxygen, nitrogen or any of the so-called inherent properties of the irons employed. In fact, Cleveland, hematite, scrap mixtures yield results equal to specially-selected cold-blast or open-hearth refined irons if the form of the graphite is initially controlled.

This may be demonstrated in various ways; if molten mild steel, plus the necessary additions of silicon and phosphorous, is run through a small cupola charged with incandescent coke, an abnormally tough iron will be obtained, although of normal chemical composition.

If a microscopical examination be made of this synthetic iron, and also of ordinary cast iron, it will be found that in the former the graphite is finely disseminated through the mass, whilst in the latter it exists as coarse flakes.

The explanation of this difference is that in ordinary pig iron the total carbon content ranges between 3.0 to 3.9 per cent., and the graphitic carbon not only possesses different degrees of refractoriness, but exists in various forms determined by chemical composition and method of manufacture. Figs. 1, 2 and 3 illustrate the form of graphite commonly met with in cast iron. Fig. 1 represents a 3-in. square block of hematite cast in dry sand. Fig. 2, the same iron cast in the form of 1-in. bars, and Fig. 3 when die-cast.

Speaking generally, the coarser the graphite flakes the more refractory does it become. In the cupola it is doubtful if a higher temperature than 1480 deg. C. is ever reached. The maximum amount of carbon which a 2 per cent. silicon iron can hold in solution when just molten is round about 3.7 per cent. Assuming that the ordinary laws of solution hold for cast iron, then at 1480 deg. C. such an iron will dissolve about 3.95 per cent. C. Cupola melting, however, is extremely rapid, and the molten iron rarely reaches this temperature; in consequence, high-carbon grey irons melted in the ordinary way always contain some free graphite.

This fact does not appear to be fully appreciated, although it may be proved by pouring the molten iron in cold water and examining it chemically or microscopically.

The effect, then, of coarsely-disposed graphite in the pig melted is to adumbrate in the molten metal the original structure and reproduce it in the finished casting to an extent determined by the rate of cooling during solidification. If, however, such a graphitic iron is rapidly solidified as by casting in chill moulds, the graphite flakes are broken up into a fine granular form (Fig. 3). Remelting this iron yields tough close-grained castings. This has been demonstrated by many large-scale practical experiments, melting in 8- and 16-ton cupolas, closely observing the quality of the finished castings and the physical test-results in conjunction with the microstructure.

That 10 to 15 per cent. mild steel should effect a further grain-refining influence if melted in conjunction with this chill-cast run-down iron can readily be understood. In fact, this mixture not only eliminates such common defects as open grain and sponginess, but renders possible the reproduction of certain physical properties to a remarkable degree of accuracy.

The maximum results obtained from daily test-bar records obtained from many thousands of tons of this iron made over long periods of time were:—C.c., 0.74; Gr., 2.41; Si., 1.5; Mn., 0.65; S., 0.11; and P., 0.50, which gave 16 to 19 tons per sq. in. tensile, and 5.0 to 6.6 tons transverse on a 12-in. by 2-in. by 1-in. bar. The minimum results were C.c., 0.67; Gr., 2.43; Si., 1.8; Mn., 0.65; S., 0.100: and P., 0.75, which gave 14 to 17 tons per sq. in. tensile and 4.5 to 5.5 tons transverse.

Oxygen in Cast Iron.

Considerable discussion has taken place recently as to whether oxygen can be found in cast iron and its effect on the mechanical properties. That oxide of iron may exist in badly-melted iron is generally accepted, and that under such conditions the addition of steel will not materially assist. Whether oxygen exists in cast iron as a gas has yet to be proved; in fact, we do not pretend to understand the chemical equilibrium between iron, carbon and oxygen. Yet some investigators go so far as to state that oxygen is soluble in cast iron and that semi-steel owes its superior physical properties to the oxygen introduced by the addition of steel. J. Johnson, junr., who first published this statement, offers no premises for his conclusion, and from the outline given of his experiments one is quite justified in asserting that the improved physical properties are an effect of hydrogen or nitrogen gases, which it is common knowledge exist in cast iron, or to the form of the carbon or to a direct temperature effect.

Chemical Composition.

It is equally certain that dirty castings and blow holes cannot be directly attributed to oxygen, as cupola melted cast iron, no matter the care taken in melting, will give dirty and blown castings if cast at a low temperature; whilst the cheapest grade of iron, whether melted with or without steel, yields clean castings if the metal is correctly melted and is cast at a good temperature.

To investigate the question of the effect of oxygen and its oxides on the physical properties and production of clean castings, a continuous series of experiments have been carried out during the past twelve months on a large and extensive practical scale by treating various grades of iron with the most active deoxidants. Amongst those tried were cerium, uranium, calcium, vanadium, aluminium, magnesium, manganese and zirconium, all of which are well known for their ready affinity for oxygen.

Cerium.

In a recently-published American investigation the following conclusions were drawn on the effect of cerium :—

" Deoxidising by means of cerium gives the purified molten metal a better chance to set under natural conditions, being relieved from a too rapid freezing action with consequent formation of undue amounts of combined carbon. The metal, therefore, is easier to machine, is freed from gas and pin holes, has a less internal shrinkage, and increases the transverse strength 33 per cent. with a proportional increase in the deflection."

Attempts have been made to confirm these remarkable statements, introducing 0.01, 0.05, and 0.10 per cent. of cerium by means of a 70 per cent. Ce, Ferro-cerium alloy in stick form. In each instance the cerium alloy was copper-plated, fastened to the end of a steel rod and plunged in the molten metal to the bottom of the ladle. This caused a violent ebullition and a slight increase of temperature.

Though many experiments were carried out with both cupola- and crucible-melted cast iron no beneficial effects could be traced to cerium when introduced in quantities up to 0.05 per cent.; with 0.10 per cent. a slight strengthening effect was found in two instances, but there was no increase in fluidity or decrease in shrinkage. In fact, there was every indication that the increased strength from the introduction of 0.10 per cent. Ce was a temperature rather than a cleansing effect.

Uranium.

This was introduced in the form of powdered ferro-uranium, containing 41 per cent. uranium, enclosed in a small sealed canister fastened to the bottom of the ladle, and the molten metal being tapped direct from the cupola.

Fluidity, shrinkage, tensile and transverse tests show uranium in quantities of under 0.20 per cent. to be without effect on the quality of ordinary cast iron.

Calcium.

These experiments were conducted on the same lines as adopted in the cerium experiments, using pure calcium in one series and ferro-calcium in another. No real benefit was found in any instance and no trace of calcium could be detected in the finished castings.

Vanadium.

Moldenke, in summarising his experiments, concludes that " to increase the breaking strength of grey cast iron a further investigation on the effect of vanadium is warranted on the part of every foundryman who has special problems in strength to master." Hatfield, after exhaustive investigation, does not attribute the slight beneficial effect of vanadium which he found in his experiments to be due to this element acting as a scavenger, but rather to its influence in preserving the carbon in the combined state.

In the author's experiments a 35 per cent. vanadium (ferro-vanadium) alloy was used, introducing in quantities up to 0.10 per cent. in the manner adopted with uranium. The test results obtained do not confirm Moldenke's assertion that small quantities of vanadium are beneficial to the production of a high-tenacity iron, whilst the hardening effect observed by Hatfield was not found; which suggests that Hatfield's results are more than probably accounted for by either a variation in the casting temperature or the initial temperature of the mould, factors which he does not appear to have taken into account.

Aluminium and Magnesium.

Extensive experiments have been conducted with these metals, introducing separately, alloyed with each other, and also alloyed with iron and copper.

The only direct and reproducible effect of aluminium found was to soften, whilst magnesium hardens. No improvement in the fluidity and physical tests could be detected by the introduction of either metals into normally-melted cupola iron.

The introduction of magnesium into cast iron is accompanied by a violent reaction, and great precautions are necessary.

Zirconium.

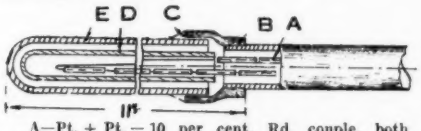
Moldenke* failed to find any beneficial effects from the use of zirconium if the iron is melted with the correct degree of heat. If, however, large amounts of steel scrap are used he states "it might be beneficial."

In the author's experiments he could detect no improvement from the introduction of zirconium in quantities of up to 0.20 per cent., whether steel was or was not melted with the iron, or whether a hot- or a cold-blast iron was used.

The collected tabulated physical test figures accompanying these experiments are excluded from this Paper on account of their bulkiness, but the comments summarise the results obtained and convey all that is necessary so far as "deoxidation of cast iron" is concerned. With reference to Moldenke's summing-up his results on the effect of zirconium, his comment as to "correctly melted" cast iron applies to practically all deoxidants, and, which is more important, to incorrectly melted iron, because no amount of doctoring will correct such iron and render it fit for use.

peratures above 1,200 deg. C. is short, no matter what combination of protecting sheathes are used, that its use had to be subsequently abandoned.

Fig. 4 illustrates the rod finally designed with the rare-metal couple. Two of these rods were made fifteen months ago, and have been in daily use at temperatures ranging from 1,300 to 1,420 deg. C., with little or no change in the E.M.F. constants or depreciation in the value of the wire. The total upkeep has consisted of six new outer protecting sheathes.



A—Pt. + Pt. — 10 per cent. Rd. couple, both wires covered with silica beads. B, Screwed joint. C, Clay luting. D, Inside silica tube—one wire only covered with beads. E, Salamander tube.

FIG. 4.—RARE-METAL COUPLE AS FINALLY DESIGNED FOR ESTIMATING THE TEMPERATURE OF MOLTEN CAST IRON.

Warming the end of the rod over a coke fire or gas burner before immersing in the molten metal, although not essential, reduces the lag to under five minutes, and prolongs the life of the refractory protecting sheath. On withdrawing from the ladle of molten metal, adhering slag should be carefully removed and the rod stored in a warm place.

A mixture consisting of 5 parts china clay, 1 part alundum cement, and 4 parts graphite, made up to a cream consistency with a 5 per cent. aqueous solution of 70 deg. Twaddel sodium sili-

TABLE I.—*Cooling Details of Cast Iron of Various Compositions.*

Mark	CC.	Gr.	Si.	Mn.	P.	S.	Incipient solidification. °C.	Main solidification. °C.	Latent heat of solidification. in gramme calories.	Phosphide solidification. °C.	Latent heat value in gramme calories.	Carbide change °C.	Latent heat value in gramme calories.	Time taken in minutes to cool from immediate solidification to: Final solidification.	End of phosphide change	End of carbide change	500 °C.
1	0.66	2.74	1.03	0.63	0.09	.063	1243	1160	27.2	960	0.8	736	13.9	43	73	176	640
2	0.60	2.67	1.15	0.62	1.54	.086	1221	1125	21.7	957	9.4	738	11.1	34	80	167	605
3	0.73	2.15	1.27	0.55	0.47	.096	1232	1153	21.1	955	3.1	747	17.2	32	79	171	590
4	0.72	2.39	1.50	0.71	0.52	.097	1210	1142	26.7	955	3.3	738	12.2	37	72	155	570
Coe.	0.17	2.54	2.01	—	0.09	—	1212	1148	—	—	—	740	—	—	—	—	—
5	0.55	2.83	2.30	0.60	0.78	.063	1165	1149	23.6	956	6.7	749	10.5	28	61	150	650
6	0.24	2.88	2.49	0.52	1.28	.050	1160	1132	22.2	960	10.0	779	8.3	30	75	154	650

Casting Temperatures.

The initial melting- and casting-temperatures are two essential factors governing the successful production of clean, solid castings. If the metal is cold on leaving the cupola bad castings are inevitable, no matter what precautions are taken in other directions. On the other hand, if it contains the necessary degree of superheat and is cast at the right temperature, little or no trouble will be encountered as far as blowholes, scum and physical test results are concerned, assuming, of course, the correct mixture has been used in the first place.

During recent years many attempts have been made to measure and so control the degree of superheat in cupola-melted iron, but with little or no success, as the temperature figures quoted by recent investigators show, these ranging from 1,300 to 1,592 deg. C.

To measure accurately the temperature of molten cast iron in the foundry an actual immersion of a thermo-couple is the only satisfactory method. To be of practical utility the thermo-couple must be robust and reasonably fool-proof.

Thermo-Couples.

Of the numerous couples tried only two have been found worthy of consideration, the one, composed of Alumel (Ni 95 and Mn 2 Al 2) Chromel (Ni. 89 Cr. 8 Mn. 1.5 Fe. 0.5), the other platinum and platinum+10 per cent. rhodium. The former has an advantage in that the first cost is low, whilst with the latter it is very high. Unfortunately, the life of the base metal couple at temcate, applied to end of the rod after use, materially prolongs the life of the refractory sheath.

By the aid of this pyrometer it has been possible to investigate many of the peculiarities of the cupola, standardise melting operations and control the casting temperature to a high degree of accuracy.

Casting Temperature v. Composition.

The effect of casting temperature was first demonstrated with crucible-melted cast iron by Longmuir in 1903. Since this investigation the importance of correct casting temperature has been recognised, although the author is not aware of any efforts to correlate casting temperature with composition.

The necessity of this may be gleaned from Table I., which sets forth the temperatures of incipient and final solidification of the irons commonly made in the cupola. These temperatures were obtained by means of platinum and platinum-rhodium thermo-couple cast just off the centre of a 6-in. cube made in dry sand, Fig. 5.

Whilst it is not possible to consider in this Paper all the factors governing the selection of the range of temperature within which any particular casting must be poured to obtain the best results, it is clearly evident that each iron must be considered on its own merits if any measure of success is to be obtained.

For general practice 10 per cent. of superheat may be taken as a working figure for castings made to specified physical test which must machine with clean faces. This means for hard irons containing a normal total carbon content, 1.0 per cent. Si. and low in P., the casting temperature should be round about 1,370 deg. C. In the presence

* American Foundrymen Association, Oct. 4-8, 1920.

of 1.5 per cent. P. incipient solidification falls 22 deg. C., so that the casting temperature is reduced to 1,343 deg. C. Iron No. 3, suitable for the manufacture of high-grade cylinders and cylinder liners and for castings to withstand superheated steam, casting temperature is 1,355 deg. C. For ordinary cylinder irons containing 1.5 per cent. Si and 0.50 per cent. P., 1,331 deg. C. A.

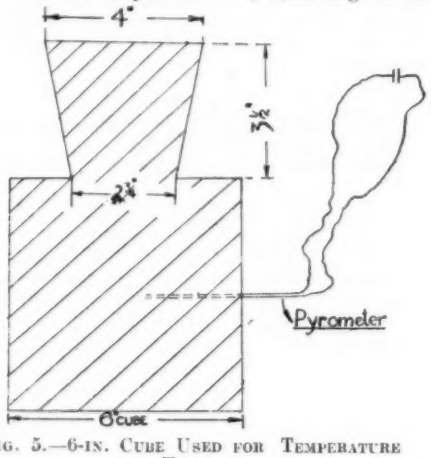


Fig. 5.—6-in. Cube Used for Temperature Tests.

2 per cent. Si, iron low in P.* commences to solidify at 1,212 deg. C., which brings the casting temperature to 1,333 deg. C. In the presence of 0.8 to 1.0 per cent. P. incipient solidification falls 47 deg. C., so that the casting temperature is correspondingly lowered; whilst for a soft-iron, high in silicon and phosphorus, it is 1,276 deg. C.

These figures, whilst amply demonstrating the correlation of composition and casting tempera-

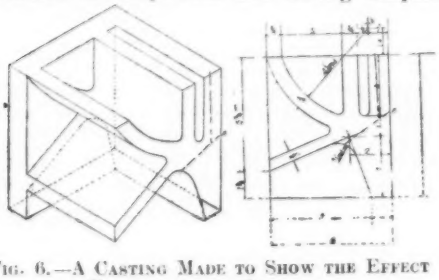


Fig. 6.—A Casting Made to Show the Effect Composition on Solidity.

ture, are by no means arbitrary. They are, in fact, only of practical value if considered alongside with the physical attributes of the irons melted, the range of temperature through which they solidify, mass effect and requirements of the finished casting.

Solidity of Cast Iron.

Grey cast iron does not possess true solidity as is understood to exist in pure alloys. The degree

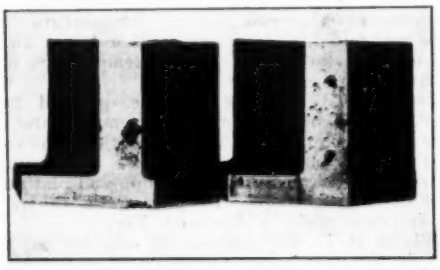


Fig. 7.—The First was Poured in at 1,370 and the Second at 1,280 Deg. C.

of solidity is a direct function of the quantity and form of the graphite present, everything else being equal. The quantity and form of the graphite being determined by chemical composition, cooling temperature, and the rate of cooling during solidification, solidity is a property under direct control. It is, of course, admitted that peculiarities are met with in the cupola-melted cast iron which are not easily explained; these, however, are the exception rather than the rule.

To exemplify the effect of composition on solidity in a practical way, a series of castings were made of the form shown by Fig. 6. This casting represents one of the most complicated sections with which the foundryman has to contend; one that is a constant source of trouble in all classes of cylinder castings, through porosity.

The castings were purposely made with the heavy section at the bottom and without risers.

The method of melting, casting temperature, head of metal, initial temperature of mould, etc., were carefully controlled throughout the experiments in order to eliminate as far as possible all variables except chemical composition.

Fig. 8.—The Middle Casting has Similar Composition to Fig. 7, but 0.25 per cent. Mo. has been Added. At the Right Hand is a High Si and P. Iron Casting.

Each casting was sectioned through AB the position of drawing according to the isothermal lines of casting.

Nos. 1 and 2, Fig. 7, depict the drawing which has occurred with an ordinary soft grey iron of the following chemical composition:—TC., 3.27; Si., 2.20; Mn., 0.72; P., 0.91; and S., 0.096; an iron commonly used on account of its apparent non-shrinking qualities. Each was cast from the same ladle of metal, No. 1 being poured hot at a temperature of 1,370 deg. C., and No. 2 poured cold, 1,280 deg. C. No. 2, Fig. 8, represents a casting made from the same alloy to which 0.25 per cent. Mo. has been added, the casting temperature being 1,360 deg. C. This experiment suggests that molybdenum minimises the drawing defect common to ordinary soft grey iron, whilst No. 3 shows the result obtained with a high Si-high P iron of the following chemical composition: C.c., 0.50; Gr., 2.84; Si, 2.50; Mn, 0.56; P, 1.83; and S, 0.046; and although an improvement on No. 2, it is by no means solid. These experiments were confirmed and various grades of other soft irons tried, but with no better results.

Fig. 9 shows the results obtained from the harder series of irons. The chemical composition of each is given in Table II.:—

Table II.—*Showing Compositions of the Castings Shown in Fig. 9.*

	c.c.	Gr.	Si.	Mn.	P.	S.	Mo.
1.	.. 0.43	2.98	1.41	0.60	0.90	0.072	—
2.	.. 0.63	2.86	1.25	0.68	0.20	0.089	—
3.	.. 0.79	2.72	1.1	0.68	0.53	0.085	0.25

A material all-round improvement is evident, whilst No. 2 (Fig. 9), a low Si, low P iron, leaves little to be desired, the casting possessing a uniform solidity throughout.

Fig. 9.—Showing the Results Obtained from Harder Irons. (See Table II.)

The results of these experiments are contrary to what one would have expected from the ordinary accepted theories of the effect of silicon and phosphorus on the volume changes of cast iron during solidification, but they clearly demonstrate the effect of these two elements on solidity. These experiments are confirmed by the results of the K test bars, which have been made daily in the foundry over a period of years.

(*To be continued.*)

* Coe-Journal Iron and Steel Institute, 1913.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Blast Furnace and the Foundry Cupola.*

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The Paper on the blast furnace and the foundry cupola by Mr. J. E. Fletcher, which has appeared in the Journal for three weeks, has been most interesting reading. It revives the conclusions reached by me many years ago, that in blast furnace operations nothing is certain except uncertainty, and perhaps it might be as well to approach the author's subject from this point of view.

There are quite a number of points in which there are common grounds for agreement, but there are others which are open to different constructions from those given in the Paper. For instance, on page 246, the author refers to erratic results, oxidised metal, etc., all of which are due to bad cupola practice. The question of the period for "best metal" is a matter of opinion.

It is however in fundamental principles where the author lays himself most open to be challenged, and it is to these it will be well to confine my remarks.

On page 269 the author suggests that a difference of 195 deg. C. in blast furnace practice may make a difference of 1.00 per cent. of silicon. Had the author added the words, "all other things being *constant*," his conclusion might have been accepted. When, however, it is accurate to say that at the same temperature a difference in burden and consequently of the slag can make a difference of not only 1.00 per cent. of silicon but considerably more, it will be seen that the author's statement requires the addition of the qualifying rider. It is not one but a combination of many different circumstances which make the considerable variations found in the analyses of the product of the blast furnace, particularly with regard to the percentages, and the character of the carbon.

Reference is then made to Gontermann's research on carbon-iron and silicon alloys. This writer gives Fe_2Si one signification, whilst G. Tammann and W. Guerther give it quite another, but both are theoretical conclusions. Again, J. Escura claims five different silicides of iron, and one has only to examine the fractures of grey and glazy irons and also observe the gelatinous silica in analysing some pig-irons to realise there is more than one silicide of iron. Mr. Fletcher quotes Gontermann's diagram on page 269, and also Hanneman's claim that 5.00 per cent. carbon at 1,500 deg. C. is the equilibrium. From this the author claims that 4.25 per cent. carbon is the *maximum* or saturation carbon content for blast furnace metal—presumably Fe. The author then applies the results of these experiments to blast furnace operations in connection with the total carbon content of pig-iron, but in addition to his table on page 230—which are all exceptions to his formula—it is necessary to give only the two following examples of pig-iron of practically the same silicon made in furnaces in two widely-separated districts manufacturing foundry quality, to show that it is not possible to compile a formula which can be applied to the numerous varying conditions experienced in the daily working of any blast furnace.

	"A" Per cent.	"B" Per cent.
T.C.	2.90	4.50
Si.	4.83	4.80
S., P., and Mn.—under ...	2.00	2.00
Fracture	Grey	Grey
Eutectic T.C.	2.30	2.30
Above eutectic T.C. ...	+ .60	+ 2.20

After allowing for the presence of P., etc., the T.C. of these two irons should be about 2.30 per cent. according to formula. Neither of these analyses confirm Gontermann or Hanneman, yet these are both virgin, and consequently natural pig-irons the T.C. of which can be explained, *but not in the way attempted by the author's formula.* "A" is not a freak, although it is admitted that "B," in carbon contents, is not a regular product, both pigs, however, form part of actual deliveries, and the total carbon and silicon of "B" were checked three times. It is, however, these exceptional examples which indicate lines of investigation outside the narrow limits of what is possible in the laboratory.

The author then quotes Saniter as having carburised iron up to 4.30 per cent. of carbon, but if he will refer to that gentleman's *laboratory* experiments published in 1897 he will find that at 1,400 deg. C. (the author's hearth temperature for (C. 4.25 per cent.) + *time* (representing metal whilst in hearth) the figure is 4.81 per cent. C. Again Girod, in the electric furnace found iron in the solid state could hold 7.90 per cent. of carbon, and considers that in the liquid condition it could hold considerably over 8.00 per cent. Further, Ruff and Georke found that at 2,220 deg. C. (just over the highest blast-furnace temperature quoted by the author as given by Clements) iron could take up practically 10 per cent. C., corresponding with Fe_3C, which they claim, and hold this percentage when quenched. These and other similar results prove my well-known contention *that, in general principle, the saturation of Fe and C. depended primarily upon temperature and time*, and varies with temperature and/or also with time. They further prove that 5.00 per cent. C cannot be taken as the equilibrium or the author's claim of 4.30 per cent. C. as the eutectic when applied to blast-furnace operations, especially when Ruff, at 1,220 deg. C., found Fe could hold 4.58 per cent. carbon. Indeed, he shows he is dubious of his claim when he modifies it by adding "it may become hypo- or hyper-eutectic in the case of cold- and hot-blast practice." Many analyses could be given to disprove the author's claims, but it is only necessary to refer to his Table 1 on page 230 to see that whilst he gives three *cold-blast* T.C.s as being *under* eutectic demands, he gives five *hot-blast* irons also *under*.

On page 231 there is what appears to be a misleading printer's error in the heading "*Graphite Ratio Constant*," as the author distinctly adds "or of total carbon per cent." A theoretical curve of the author's eutectic total carbons alongside the actual total carbons do not, it is feared, prove the author's contention of showing the heat of the furnace hearth, especially if he depends on graphitic carbon per cent. for proof. The following analyses "C" and "D" are both No. 1 hot-blast hematites with a sulphur content of 0.04 and 0.034 per cent. respectively, showing both furnaces were working hot, as were also the hearths, otherwise the fractures would not be open No. 1 nor the S. so low.

	"C" Per cent.	"D" Per cent.
Actual T.C.	3.65	3.67
,, C.C.	.57	.17
,, G.C.	3.08	3.50
,, Si.	1.46	4.98
Eutectic T.C.	3.88	2.87
Actual C.C.	.57	.17
Eutectic G.C.	3.36	2.70
Actual G.C.	3.02	3.50
	− .23	+ .80

Both total carbons are the same, but "C" is −0.23 per cent. of the author's eutectic requirements, whilst "D" is + 0.80 per cent., and the same − and + figures apply to the author's graphitic carbon eutectic requirements or *constant* graphite ratio.

One more example. A few years ago a Scotch furnace producing ferro-silicon made a quantity containing Si. 16.00 per cent. with an *open No. 1 fracture, perfectly grey*, showing the presence of a large percentage of graphitic carbon and hence total carbon. Total carbon was not given, but taking the author's formula for silicon as − 0.286 for each per cent. deducted from his eutectic total carbon, we have the following:—

Total carbon, 4.30 − (0.286 × 16).

or total carbon, 4.30 − 4.576 = T.C. − 0.276.

That is to say, under an assumed 4.30 per cent. total carbon eutectic theoretically it is impossible

* Mr. Fletcher's Paper was read before the South Staffordshire Iron and Steel Institute.

to have any carbon or graphite present in a 16 per cent. ferro-silicon, yet as a matter of fact large flakes of graphite *were* present, suggesting a total carbon content (as graphite carbon) of 2.00 to 3.00 per cent. This is quite in keeping with "B" analyses mentioned earlier and showing 2.20 per cent. C. *above* eutectic demands.

Without obtaining special permission the details cannot be published, but Mr. Fletcher can take my assurance that it is a fact, as the investigation came under my personal notice, that under certain conditions of working a blast furnace the total carbon increases with the rise in silicon, which is quite the opposite effect to that suggested by the author's proposed formula, which facts are also capable of explanation when the conditions governing the phenomena are known.

As we do not know the temperatures, particularly in the modern blast-furnace, although Clements estimated the highest at 2,100 deg. C., nor definitely what actually takes place in the furnace hearth, it is not possible to say what is the saturation point of Fe and C. under furnace working conditions, for it is quite apparent that this will vary for the reasons stated. Therefore, it is not possible to give a formula which will govern the saturation or eutectic or equilibrium of C. in pig iron of given chemical composition, nor can any such formula explain :—

(i.) The difference between "A" and "B," "C" and "D," etc.

(ii) Saniter's, Girod's or Ruff and Georke's varying percentages of C. in Fe.

My reason for this criticism is similar to that given by Mr. J. Shaw in his letter re cupolas on page 257 of The Foundry Trade Journal. Any definite formulæ given in the present state of our imperfect knowledge of cast iron are liable to mislead those with a little knowledge—which is always a dangerous thing—and the blast-furnace and foundry manager's life is sufficiently difficult now, without adding anything more to their burdens. With this Mr. Fletcher is certain to be in agreement, and in view of the tendency in some quarters to make demands for pig iron within narrow limits of analysis, including carbon, he will allow it is wise to qualify what may appear to some to be dogmatic statements capable of practical application, both at the blast furnace and in the foundry.

Yours, etc.,

E. Adamson.

April 22, 1922.

Foundry Competitions at Birmingham.

To the Editor of The Foundry Trade Journal.

Sir,—We should be glad to learn whether Section I. of Class C (patternmaking) is really open to foundrymen over 21 years of age, because the application form (enclosed with the circularised conditions) emphasises rather strongly that the age limit is 21. As this must be of general interest we consider correspondence would be saved if Mr. Vickers would reply through the medium of your columns.—Yours, etc.,

J. Smith.

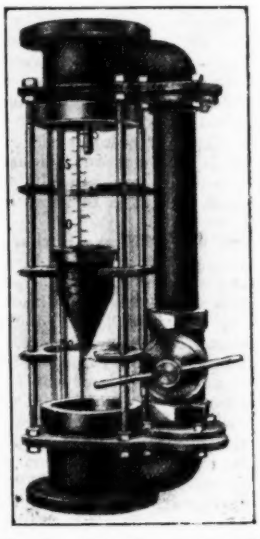
Fusion of Iron and Steel Associations.

The important announcement is made that four of the leading iron and steel trade associations are to be amalgamated, which will, it is hoped, lead to greater simplification and more expedition, particularly in regard to wage matters. The four associations concerned are the Steel Ingot Makers' Association, the Scottish Steel Makers' Wages Association, the North of England Iron and Steel Manufacturers' Association, and the Midland Steel Rolling Mill Employers' Association. This multiplicity is now to end, and in future the four will be merged, with the title of the Iron and Steel Trades Employers' Association.

For the purpose of organisation, general administration, and convenience in dealing quickly with questions as they arise, the areas covered by the various bodies have been partitioned into three divisions, viz. : (1) Scotland. (2) North-East Coast of England, and (3) Lincolnshire, South-West Yorkshire, Midlands, and West of England. Each division will have its divisional secretary, and for the present the head office of the Association will be at the Royal Exchange, Middlesbrough. Mr. John A. Gregorson, Middlesbrough, is the secretary, Mr. L. Ennis the president, and Mr. Edward C. Greig the vice-president.

The Rotameter.

Messrs. Trost Brothers, 26, Little Park Street, Coventry, have sent us some particulars relating to the "Rotameter," which is a simple device for measuring the rate of flow through a pipe, per minute or per hour, of any gas or liquid, in cubic feet, gallons, or lbs., or in metric measures. The appliance is used for measuring and regulating the flow of air, illuminating gas, hydrogen, oxygen, acetylene, ammonia, chloride, carbonic acid, carbonic oxide, nitrogen, methane, compressed air and other gases, vapours, and liquids. It is made in all sizes, from a minimum of about 3 cub. in. per hour to a maximum of about 35,000 cub. ft. per hour, when connected directly in the pipe line. For larger capacities a special type is supplied, which is provided with a by-pass device.



As shown in the accompanying illustration, the "Rotameter" consists essentially of a vertical transparent tube with a bore tapering towards the lower end. Within the tube there is a circular top-shaped float; the stream of gas or liquid flowing through the tube lifts the float. By means of an accurately-calibrated scale fixed to or engraved on the transparent tube, the quantity of gas or liquid passing through is directly read off the scale from the position of the float. The accuracy of the apparatus lies in the peculiar construction of the float, which is kept in rapid rotation by the stream of gas or liquid flowing past it. The float does not touch the walls of the tube and the instrument is frictionless. The rotational movement of the float is much more sensitive to disturbance than the vertical movement, and consequently there is a continuous check upon the accuracy and proper functioning of the instrument; after long use the float and tube may become fouled, and when a certain degree of fouling is reached the float will cease to rotate, thus giving warning that the instrument requires cleaning; but it is important to remember that the rotation ceases long before the accuracy of the vertical motion of the float, and consequently of the readings, is appreciably affected.

Symposium on Electric Cast Iron.

At the annual general meeting of the American Electrochemical Society, held in Baltimore on April 27, 28, and 29, a symposium on electric cast iron was arranged by Messrs. Bradley Strongton and A. T. Hinckley. The Papers presented were as follows :—

George K. Elliott : "Cast iron as produced in the Electric Furnace and some of its Problems."

R. C. Gosrow : "A Comparison between the Shaft and Open-top Furnaces in the Manufacture of Pig Iron Electrically from Ore."

Robert Turnbull : "Synthetic and Electric Pig Iron sanely considered."

Clyde E. Williams and C. E. Sims : "A Study of Carburisation in the Manufacture of Synthetic Cast Iron."

W. E. Moore : "Electric Cast Iron."

J. L. Cawthan : "Operating Data Obtained in Electric Furnace Cast-Iron Foundry."

H. M. Williams : "Melting of Cast Iron in the Booth Rotating Electric Furnace."

Innovations in Cupola Practice.

For the production of high-grade castings in cast-iron for special purposes, such as piston rings, cylinder liners and similar castings, the desirability of being able to exercise some control over the composition of the metal has been appreciated by engineers and foundrymen handling this class of casting. The ordinary foundry cupola has its limitations in this respect, and various methods have been resorted to from time to time with a view to either eliminating the shortcomings of the cupola melting plant or devising new means of melting which would enable some measure of control over the character and composition of the metal being exercised. The use of hearth furnaces of the reverberatory type or equipped with regenerators has been adopted by certain foundries, and in others a system of melting the cast-iron in crucible melting holes has been devised. These methods, whilst avoiding the defects of the cupola melting method also eliminate the cheapness and delightful simplicity and convenience of the cupola melting plant. Probably no metallurgical melting process is as cheap or simple and convenient as the latter mentioned.

The use of a cupola in conjunction with a receiver is quite common, and in part overcomes certain of the objections attached to the straightforward cupola method, in that it ensures to some degree the intimate mixing of the successive charges and removes the molten metal from prolonged contact with the bed coke in the cupola. The use of an electric furnace in conjunction with the cupola, a method which is now familiarly known as the duplex process, is probably the ideal method of melting cast iron for use in high-grade castings. This duplex method has been adopted in America, but even in that country the expense of the plant and the operating costs have been a bar to its extensive employment.

The plant described below has been adopted by Messrs. Centrifugal Castings, Ltd., of Kilmarnock, for supplying high-grade molten metal to meet the needs of their centrifugal casting process, for the production of high quality cylindrical castings for piston rings, gas and oil engine cylinders, and the like. The plant has been designed by Mr. J. E. Hurst, the managing director of the company, and combines the advantages of the plain cupola melting system with those of the open-hearth system without seriously adding to the cost of production of molten iron. The melting plant consists of an ordinary foundry cupola combined with an elevator charging device, and an oil-fired receiver. Fig. 1 illustrates the complete plant, and a vertical section through the receiver and a plan view of the complete plant are shown in Figs. 2 and 3 respectively.

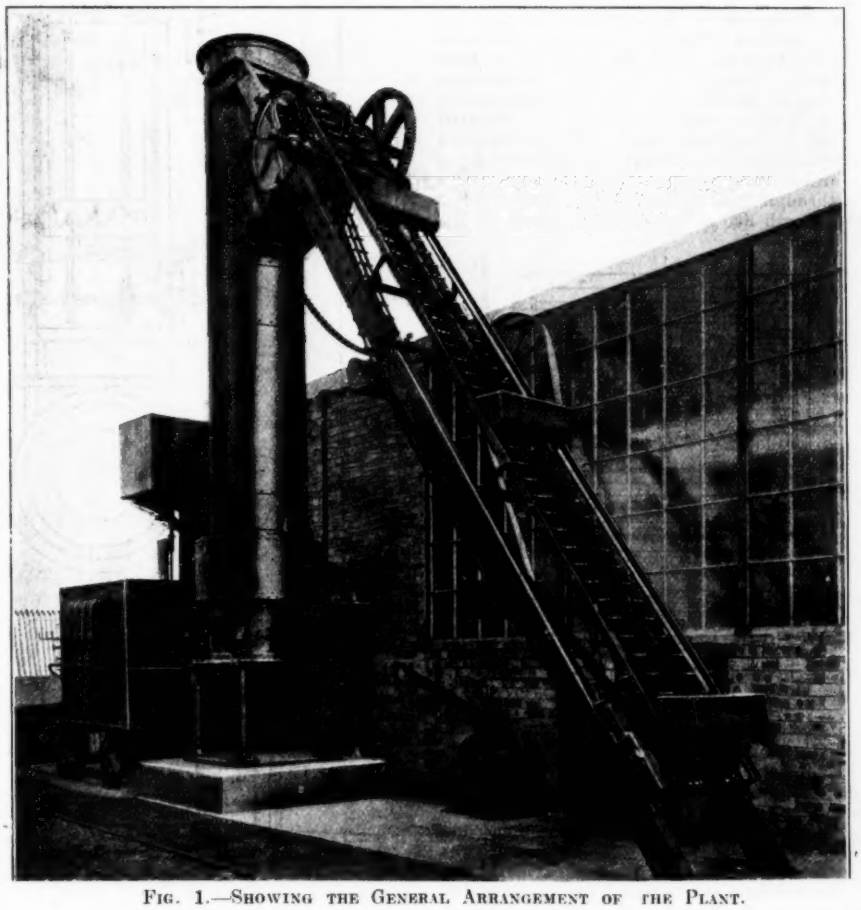


FIG. 1.—SHOWING THE GENERAL ARRANGEMENT OF THE PLANT.

The cupola itself is of the ordinary drop bottom type, of a capacity of 2 tons per hour. The charging of the pig-iron, scrap, coke, and limestone is effected by means of a bucket type elevator discharging direct into a specially constructed shute leading through the ordinary charging door. It has been frequently asserted that direct elevator charging in this manner would not prove satisfactory, a view which is probably based upon the supposed difficulty of ensuring regularity of the charging and hence regularity in the composition. In a cupola of small diameter, however, this method of charging is equally as effective as hand charging, and in any case since large portions of the melt are collected in the receiver the ultimate regularity in composition of the metal is outside the realm of the charging method. In large diameter cupolas a form of elevator charging has been adopted by certain foundries where the whole of the charge is dropped through the open top of the cupola from specially designed trucks.

In this particular plant the position of the tuyere belt on the cupola has not been altered, and the normal bed is formed for melting in the cupola. The tuyere belt could be lowered with advantage.

and a considerable saving in bed coke thereby effected. The cupola has been provided with two tap holes, one leading into the oil-fired receiver and the auxiliary tap hole for use in cases of emergency, and for withdrawing slag during the stoppage for meal hour. An auxiliary tuyere leading from the blast box into the bed exactly opposite the tapping hole leading into the receiver was found necessary to keep the bed hot and the tap hole open during the early stages of the melt.

The oil-fired receiver consists of a shallow hearth totally enclosed in refractory brickwork mounted in cast-iron framing, the whole carried on wheels to enable the receiver to be moved away from the cupola for repairs or for use in the ordinary manner as desired. The receiver is equipped with a tapping spout and a special charging door. The tapping spout has been hinged in such a manner as to drop down disclosing a large hole or breast through which the hearth can be "fettled" after each day's melt. The door is provided to enable additions of pig-iron or ferro-alloys to be made to the bath as desired. The receiver is equipped with four oil-fired burners of the low-pressure air type supplied with air from the fan blower which supplies the cupola. Fuel-oil is supplied to the burners through a flexible connection from an elevated tank shown in the illustration. The air supplied to the burners is led through regenerator pipes fixed in an auxiliary chamber above the roof of the hearth, through which chamber the waste gases from the hearth are led by means of ports to the outer atmosphere.

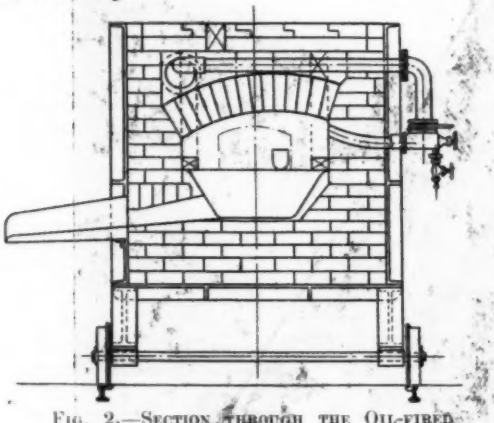


Fig. 2.—Section through the Oil-fired Receiver.

In actual practice the bed of the cupola is charged on and when starting from "all cold" the full complement of oil burners are lighted. The oil furnace is brought to a temperature sufficiently high to receive the molten metal during which time the cupola is being charged. Melting is then commenced in the cupola, and the molten metal runs direct into the receiver. As the molten metal collects in the receiver and is withdrawn to meet the requirements of the foundry, the burner capacity is gradually reduced accordingly, and a comparatively small amount of oil is required to maintain the temperature, after the metal has been flowing through the plant. If mixings are added to the metal, then it is, of course, necessary to increase the burner capacity and maintain them at full bore to effect melting.

In actual practice the oil-fired receiver readily maintains the temperature of the metal. As small a quantity as 10 cwt. of molten metal was held at the correct casting temperature for a period of two hours during the initial stages of starting up the plant. The maximum oil consumption of the full complement of burners when open full bore is 27 gallons per hour. The full capacity of the burners is utilised during the starting up of the receiver, and when in regular use the receiver can be raised to a sufficiently high temperature to receive the molten iron in half-an-hour.

The actual oil consumption figures vary considerably according to the details of the daily practice and manipulation. The average consumption is 30 gallons per cast of five hours, which is equivalent to a consumption of 3 gallons per ton on the full melting capacity of the plant over that period. Naturally the longer the melting period and the greater the output, the lower is the oil consumption figure on a ton basis.

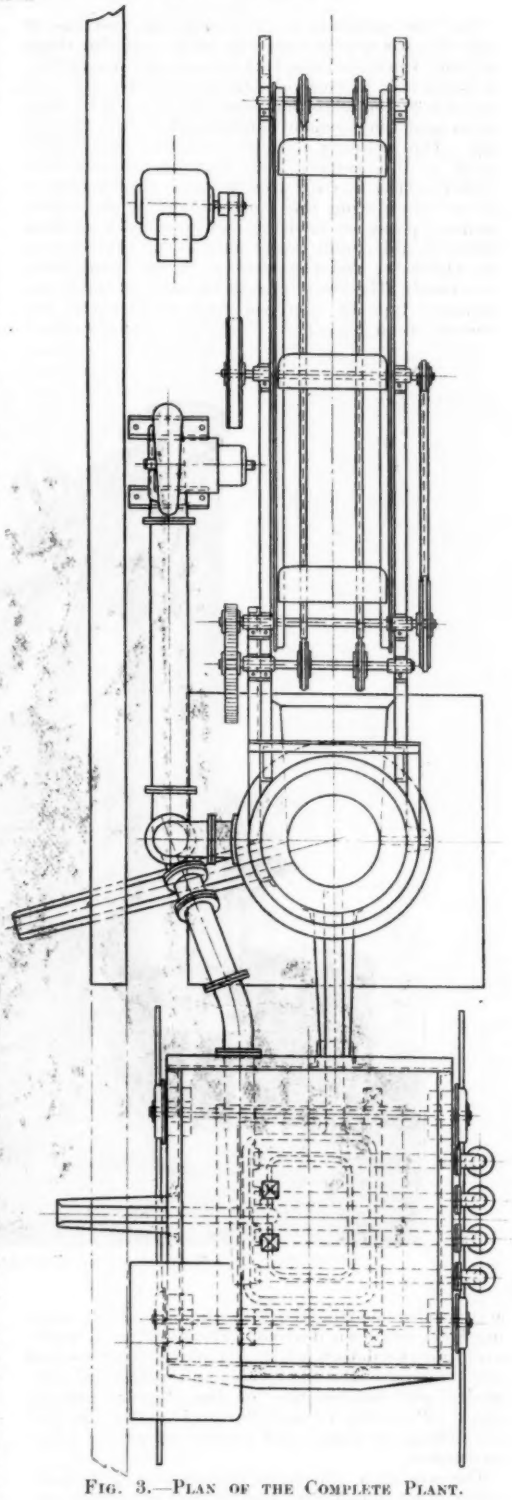


Fig. 3.—Plan of the Complete Plant.

We are indebted to Messrs. Centrifugal Castings, Limited, for permission to describe and illustrate this plant.

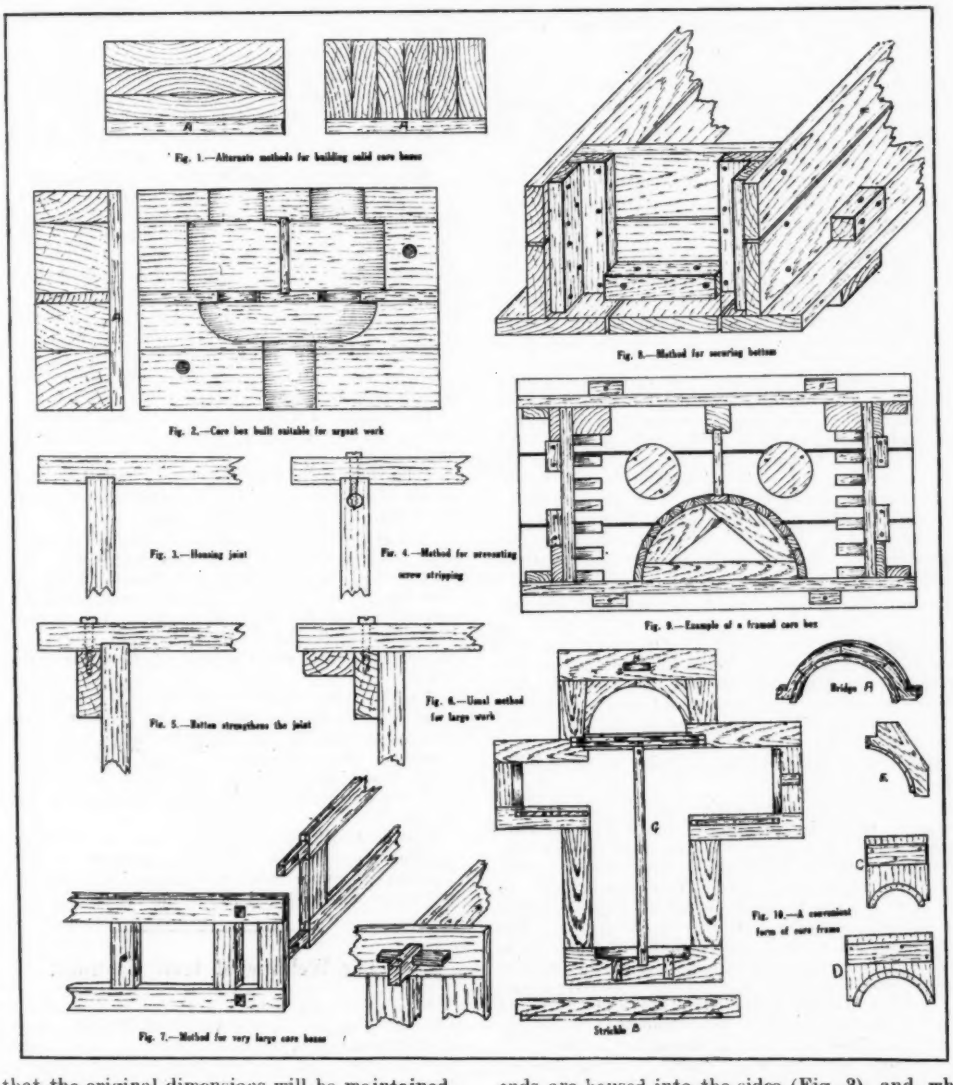
The annual report of the Consultative Committee of Shipbuilders and Engineers, appointed to confer with the Marine Department of the Board of Trade, summarises the questions which have been discussed. These include the inconvenience caused by the continued postponement of the operation of the provisions of the International Convention, discharge valves on ships' sides, motor lifeboats, the sub-division of home trade vessels, indicators on valves, oil fuel on ferry steamers, tonnage measurement, Suez and Panama certificates, etc.

Core-Box Construction.

BY BEN SHAW.

The economical construction of core-baxes is of vital importance in considering the cost of pattern work in relation to the finished product. It is the truest economy to determine the quality of pattern work desired by the number and quality of castings required. In any case it is desirable that the core-boxes supplied should be accurate and be so constructed that they maintain their correct form. The majority of core boxes are constructed in wood, a material which is weak in the direction of the grain and strong across it. It is also influenced by moisture, increasing and decreasing as it absorbs and gives off moisture. These two weaknesses of wood necessitate care in construction of core boxes so that the original dimensions will be maintained.

With the exception of very small core boxes, which are generally cut from solid timber, all core boxes are built up in some form. When it is required to be solid, a number of pieces of timber are used to make up the size desired. Two methods preferred for building solid core-boxes are shown in Fig. 1. In glueing and screwing pieces together for this purpose the convexity of the annual rings should be next to each other alternately. The edges are then not so liable to open when the core box is in use. Battens are carried along the bottom of such boxes, as at AA, when possible. Screws are sometimes a source of trouble, especially when carving is to be done; then it is better to depend upon the glued joints and introduce screws when the box is completed. Building core boxes with the wood jointed in a vertical direction is particularly useful for certain classes of work which are required urgently, especially when the pattern-shop does not possess a pattern-making machine. This is illustrated by the half-box for a valve chest, shown in Fig. 2. By making up the box in suitable thicknesses and securing them temporarily, until dowelled and the shape marked off, then they are separated, when the majority of the cutting out can be done on the band saw and finished on a bobbin mander. The pieces can then be re-assembled and battens secured across the bottom of each half-box. Framed core-boxes are used to a considerable extent, even though the core required may not be rectangular in shape, because they form a substantial exterior to which pieces can be attached conveniently for making the desired shape. Such boxes facilitate stripping after the core has been made and they are less subject to change of form due to the absorption of moisture. The method of jointing these framed boxes varies. With comparatively small boxes the ends are housed into the sides (Fig. 3), and, when they are to be separated in stripping the core, screws are used to secure the parts. When the box is to be used many times it is profitable to introduce a piece of dowel stick, as in Fig. 4, into which the screws can be fixed. This dispenses with the necessity for increasing the size of screw almost every time the box is used. When the box required is a little larger and deeper, the housing joint is retained, but battens are secured to the ends having the grain in the opposite direction (Fig. 5). These receive the screws and give greater security. In the construction of medium and large sized boxes the housing joint is usually dispensed with, battens being secured to the sides as well as the ends, and are used as a check for setting the ends correctly, as shown in Fig. 6. Wood does not change its shape appreciably in the direction of its grain, so that as far as the rectangular shape is concerned, the correct size will be maintained, with ordinary use; but wood is affected across the grain, therefore the height of such a box is likely to vary.


A
A
Fig. 1.—Alternate methods for building solid core boxes
Fig. 2.—Core box built suitable for urgent work
Fig. 3.—Housing joint
Fig. 4.—Method for arresting screw stripping
Fig. 5.—Batten strengthens the joint
Fig. 6.—Usual method for large work
Fig. 7.—Method for very large core boxes
Fig. 8.—Method for securing bottom
Fig. 9.—Example of a framed core box
Bridge A
B
C
C
D
Fig. 10.—A convenient form of core frame
Striddle B

Two methods are adopted to reduce this tendency, framing the sides and ends, as shown in Fig. 7; or, when full surfaces are desired, by making the total width from a number of pieces and leaving an open joint between them. If the pieces are 5 or 6 ins. wide the open joints between them localise the change of form and thus limit any change over the whole width to that which takes effect on one piece. As a rule the battens which are secured to the sides and ends are made a little less than the total height of the box, consequently the core-maker is not able to determine whether the height of the box has changed. It is more sensible to make the battens the correct length of the core, then any variation from the battens can be remedied before the core is introduced into the mould. Another method for securing framed boxes is illustrated in Fig. 7. The ends carry tongues which pass through suitable holes in the sides against which they are wedged. This type of box is sometimes used for very large work, hook bolts being frequently employed at each end and between the two sides to maintain the correct shape.

In many cases it is necessary to have a bottom on the core box in order to carry parts which are to give the requisite shape to the core. It is equally as necessary to adopt the method of open jointing in the formation of the bottom plate. It is not so much the method of preparing a bottom that many pattern-makers are at fault, but rather in the method of securing it to the box. A bottom should not be used unless it is essential because a core-maker prefers to make the core direct on a plate or prepared bed, but, when a bottom must be used, then it only increases the trouble of the core-maker if it is secured to the box with screws passing through it. The correct way is to attach buttons or blocks to upper surface, as shown in Fig. 8. The buttons should be fastened to the sides of the box first and then the box is located accurately on the bottom and finally secured with screws passing through the buttons. Frequently sides or ends can be stripped without removing all the buttons, and this makes it easier to re-assemble the box for the next core. Fig. 9 illustrates a plan view of a framed core box, showing the method of introducing pieces to give the required shape.

The use of cheese-headed screws is strongly recommended for attaching parts which are to be separated by the core-maker. Ordinary countersunk screws are usually below the surface of the wood, and gradually get deeper the more the box is used, becoming filled with sand and a nuisance to the moulder. When the head of the screw projects beyond the surface of the box it is more easily discovered, and as a rule more quickly removed.

Many cores of a cylindrical character are economically made by means of core plates or core frames. They are quickly constructed in the pattern-shop and are particularly useful when only a few castings are required. The core is made in halves, which are bonded and wired together after they are dry. A core plate merely consists of a flat plate upon which the correct shape of the core is marked, having pieces secured to it at the ends of the proposed half-core cut to the desired shape, and guides attached for strickles. The framed plate is somewhat similar, excepting that the shape of the required core is cut through the plate; it is therefore preferable to half-lap a number of pieces together to form a frame about the core shape. The shaped ends and guides are the same as for a core plate. The core frame is the most economical when halves of a core are required; it can be stripped directly the half core has been made and the next half commenced; whereas the half core on a plate must be allowed to stiffen before it can be moved in order to proceed with the other half. A core frame, an example of which is shown in Fig. 10, is usually made about ¾ in. thick. Shaped pieces are secured to the frame so as to represent the true shape of the ends of the half core from the under side of the frame. The bridge A, carrying guides on each side, is also secured to the frame to complete the shape for the straight part of the core. A stiffener secured as at G will keep it vertical. The straight strickle B is suitable for giving the shape to the main part of the core. For the spherical end it is convenient to have a small semi-circular piece, less the thickness of the frame, at H, upon which the strickle E will ride, to form the desired shape. The branch cores can be formed with the strickles C and D, which resemble half-height boards; they are, however, cut to rest on the top of the frame and recessed to suit the guides. It must be remembered, of course, that when the core is not symmetrical it is necessary to reverse the core frame or core plate after the first half-core has been made. To prevent errors it is better to mark the pieces in each position before it leaves the pattern shop.

Book Review.

Canada as a Market for British Goods, with introductions by Sir Peter Rylands and Stanley Machin, J.P. Published by Messrs. Selwyn & Blount, Limited, 21, York Buildings, Adelphi, W.C.2. Price, 7s. 6d. net.

The object of this book is to show British manufacturers how they can sell their products in Canada. It does not merely theorise but actually gives information of a practical character, such as the names of reliable merchants, addresses of advertising agents and specialised lawyers.

What concerns foundrymen is whether they can sell their goods in Canada, and from statistics given in the book, we gather that Canada is quite well equipped in this direction, and the amount imported is insignificant. However, many foundries are not in business solely to make castings, but these often form a department of a works, making machinery of the "speciality" type, and amongst these are products which might possibly be sold in competition with the United States, who last year exported 800 million dollars' worth of goods to Canada.

In Chapter 1 a comparison is made between pre- and post-war Canada, whilst the second chapter deals with Canada's vast natural resources, and incidentally puts forward a case for the establishment of branch factories—in which we should only be following an American lead.

The third chapter eulogises Canada's transportation facilities, both rail and water-way. The fourth section deals with the Canadian market by Provinces, indicating in each case any special opportunities for British trade. American competition is specially referred to in chapter five, which contains an analysis of Canadian import trade.

The last two chapters are of an extremely practical character, and outline the present available sources of information, agencies, advertising, trade journals, transportation of goods, Customs regulations, banking facilities, Canadian company law, and a concise directory of the importers of British goods.

The book differs materially from the Government publications, which take for granted a certain amount of experience in international trade. It is concise and cloaked in simple language.

The Welding of Iron Castings.

Mr. G. C. Carter, in a Paper read before the Cleveland section of the American Welding Society, states that in Cleveland there is one company where welding of iron castings in production work has been wonderfully systematised and almost perfect results have been and are being obtained. This company is the Ferro Machine & Foundry Co., where hundreds of automobile engine castings are made each day. When small blow-holes or other superficial flaws are noted in engine block castings, the castings are sent to the welding room, where they are pushed into a big annealing furnace which slowly heats them to a bright red heat. The properly-heated castings are then carried to welding stations, where the welders fill up the grooved-out places, using the usual cast-iron filler rods and fluxes. The welded castings are then carried to a sand pile, where they are buried until they have cooled slowly, after which they are sent along in the regular line of production.

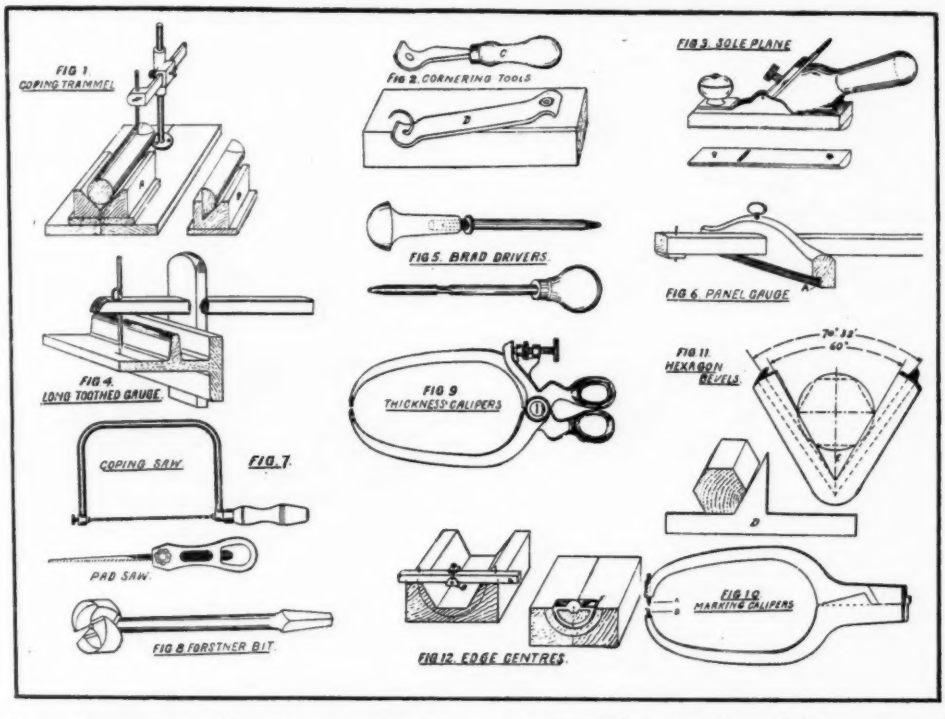
Incidentally it may be noted that through use of a furnace which is heated by oil or gas there is a large saving in oxygen, acetylene and welding time, which more than offsets the initial preparation costs so necessary for quality.

Some Small Time-Saving Pattern-maker's Tools and Devices.

Mr. W. P. Essex, writing in the "Canadian Foundryman," outlines a selection of tools which have found favour in Canada. Whilst some are common in this country, others certainly present novelty. The following is an extract of Mr. Essex's article.

In the following illustrations and descriptions, the writer submits a carefully made selection of special tools and devices particularly helpful to the patternmaker.

A tool that will be found exceedingly useful for scribing semi-circles on round or irregular-shaped portions of patterns, is the coping trammel shown in Fig. 1. It is of very simple design, consisting of a metal base-plate with a substantially fixed vertical spindle on which a rotating head is free to slide up and down. An offset on the side of the head has a square hole through which slides a radius bar adjustable to different radii, which are struck with a steel scriber or pencil held by a thumbscrew in the end of the bar. In use the device is fixed to a level board, the axis of the vertical spindle intersecting with a well-defined line drawn through the centre of the board and parallel with its sides. V blocks, or cradle, as shown at A and B of various sizes provide a most convenient means of holding the piece of work in position for scribing. This tool is adaptable to a wide range of work, particularly for marking round, oval, hexagon, or other shaped parts, for offsets or branches which are to intersect with the circular portions of a pattern. With the radius bar removed and laid parallel with the spindle, the tool may be packed into a very small space, and, if the head be made of an aluminum alloy, it will not be found too heavy for the kit case.



The Cornering-Tool.

It is generally considered good practice nowadays to round off all sharp corners from patterns, where square corners are not absolutely necessary. A couple of very handy tools are shown in Fig. 2, specially adapted for this purpose. The one marked C is possibly the best one to use, but D is a more convenient shape, having two cutters of different size in the one tool. These are made of flat steel about 3-16 in. by 1 in., and 6 in. or so in length. There should be a pair of these tools, one with cutters for $\frac{1}{4}$ and 3-16, and the other for $\frac{1}{4}$ and $\frac{3}{8}$ radii.

A very convenient shop-made tool of excellent design is the sole plane illustrated in Fig. 3. Many uses will be found for this handy shaped plane, especially in working out core boxes of diameters larger than 3 in. There should be a number of detachable soles and round irons of varying radii provided, to correspond to diameters from 3 in. to 18 in.

The long-toothed gauge, Fig. 4, will be found very convenient when a parallel line is necessary on that part of a pattern which is not on the same level as the side desired to gauge from, as seen in illustration, or in gauging to parallel widths or sharp sweeps. Practice will suggest to the patternmaker many other uses for this valuable tool.

It is wasteful of time as well as annoying to pick up small brads with the fingers, sticky with shellac or glue, and repeatedly trying to start them in the wood, and after each attempt to find the brad sticking to the finger instead of in the wood. It is also exasperating to have to pull out from a piece of work several crooked brads which have bent in the attempt to place them with the pliers, in an awkward corner of a pattern, or in the deep recess of a core box, not getatable with a hammer and nail set. For bradding work in difficult places inaccessible by ordinary means, one or the other of those patented brad drivers shown in Fig. 5 is recommended as a time and temper saver. The brad is magnetically picked up by the brad setter and securely held in the end of the tool, and with a slight pressure on the tool is driven into the wood without bending it. It is not even necessary to use a nail set, for the driver will set the brad deep enough, whether it be hard or soft wood, cardboard, or leather.

The panel gauge, Fig. 6, is essentially a joiner's tool, but the patternmaker also finds frequent use for it. While used for practically the same purpose as the marking gauge, its proportions are larger, and it is mostly used in gauging widths over 6 or 8 in. The sliding head is usually made about 7 in. long, and the beam from 18 in. to 2 ft. The work is gauged from the rabbet A, which insures steadier guiding of the gauge than a plain face, the end of the beam at the marking point is made thicker, to line with the rabbet in the sliding head. In laying out drawings on a large board, the panel gauge will be found very useful.

In the making of small and medium-sized patterns, especially that line of work which includes articles like pipe fittings, where branched and offset parts are coped on to other parts of a pattern, the coping saw, Fig. 7, can be used to good advantage for this class of work, and will be found to be a much better tool for a job of this kind than the gauge. The pad saw is another good tool to have in the kit, as it will save many a trip to the band saw for a trifling cut. It also comes in very

handy for small jobs of inside sawing, where a jig saw is not available.

Patternmakers will find the Forstner bit, Fig 8, to be a very useful tool. This bit differs from all other boring bits made for working in wood, it being guided by the rim instead of the centre. This unique construction permits of it being started on or over the edge of the wood, so that any arc of a circle corresponding with the diameter of the bit can be bored. The writer's experience with these bits in a limited way has been very satisfactory, working exceedingly well in pine wood, and leaving a clean-cut hole. It is claimed for them that they will cut through tough, hard, knotty, cross-grained wood, and leave a smooth hole, and a clean surface. As they have no centre spur they have the advantage over other bits of leaving a flat-bottomed hole, which is often desirable, especially for making depressions in patterns that have to be planed out with a router.

As a means of quickly determining the thickness of material in parts of a pattern or casting that are difficult of access for measurement, as, for example, over flanges, or the inside of cavities, or to obtain the thickness at the bottom of a depression, there is no tool more suitable than the thickness calipers, shown in Fig. 9. It possesses practically all the features of the regular transfer calipers, and for adaptability has advantages that the regular transfer type of caliper does not possess. It is particularly useful in relieving the back of carving in ornamental patterns like stove plate, to maintain a uniform thickness, or in backing out small master patterns for lightening the metal patterns for match plating.

The marking calipers, Fig. 10, are used principally on stove plate and ornamental pattern work where a design carved on the face of a pattern has to be relieved on the reverse side. The calipers are held in the hand, and the steel point B is made to follow around the carved design, the pencil A marking the outline of the pattern on the other side.

A simple device that will save considerable time in laying off and marking hexagons on round work is shown at C, Fig. 11. To obtain this useful little tool, it may be necessary to spend a few minutes in making a pattern, and have one cast in brass. The face with the 60 deg. angle need not be more than $\frac{1}{4}$ in. thick, with a flange $\frac{3}{8}$ in. wide set at an angle of 70 deg., 32 min., the vertical line E bisecting both angles. D is a combination gauge and square for marking and fitting hexagons.

When striking an arc on a piece of work from a centre point on the edge of the material, as in marking the ends of a block for a core box, a common practice is to clamp or hold a piece of wood to the edge of the work, in which to place the point of the compass while striking the half circle. A more convenient way, and just as accurate, is found in the use of the edge centre shown at F in Fig. 12. This is sometimes made of cast metal, but is uusally made by bending a stout piece of sheet brass at right angles, and carefully locating the centre point and lines, then working it to the shape shown in illustration. G shows a little device with a small hole for a centre, for clamping a square rod to use on a stepped or lagged box. Most patternmaking kits will contain some of these tools, but not in many kits will most of these tools be found.

Corrosion Tests.

The U.S. Bureau of Mines, from experiments made by exposing the polished surfaces of various metals to the atmosphere for 19 days, found that the resistance was in the order given below :—

Annealed stainless steel (carbon, 0.15; chromium, 13 per cent.).

Annealed high chromium and high nickel steels.

Forged stainless steel.

Cast iron-chromium alloy (carbon, 0.04; chromium, 6.5 per cent.).

Annealed chromium steel (carbon, 0.20; chromium, 8.6 per cent.)

Annealed chromium steel (carbon, 0.30; chromium, 5.72 per cent.).

Annealed chromium steel (carbon, 0.28; chromium, 3.90 per cent.).

Pure iron.

Iron carbon alloy (carbon, 0.45 per cent.).

The Milling of Sand.

Many foundrymen have had difficulty with their sand-grinding mill. Amongst the troubles is belt slipping, due to sand being caked on bottom of pan, which the scrapers have been unable to remove; the resulting sand is in cakes, and even when riddled contains a number of hard pellets of sand, even when passed through a finely meshed sieve. The result is seen in a rough face on the casting, and to makers of light castings this is a serious trouble. Some foundries put in a disintegrator of the centrifugal type, which, so far as the sand goes, certainly improves matters. The trouble with the belt constantly requiring tightening still continues, and sometimes to give extra power the speed of the rollers (or pair in the case of a revolving pan) is reduced, but this is against speed in preparing the quantity of sand required. In some foundries this is enormous, and perhaps may mean another sand mill. The mill attendant finds that with a 4-ft. pan-mill, which should mill a barrowful at one filling, that he puts in this quantity and gets out a riddlefull. This means that the scrapers are not doing their work, and therefore they are continually requiring adjustment, and consequently stopping of the mill. With scrapers working efficiently and the belt in good condition the caked-sand trouble still remains, and any new sand put into the mixture appears as so many patches instead of being distributed throughout the whole mass. This means using more red sand per mix than necessary, and sends up the sand bill, whilst the skin of the castings suffers. What is required is a mill that will deliver aerated sand of a loose texture, without losing its toughness, and a sand that is homogeneous; probably as a result of thorough mixing reducing red-sand consumption by as much as 75 per cent.

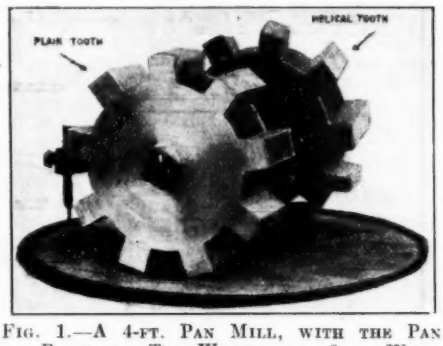


Fig. 1.—A 4-ft. Pan Mill, with the Pan Removed. The Wheels are 2-ft. Wide, and Weigh 2 cwt. each.

These results *are* being obtained without passing through another machine, and can be obtained by any founder possessing a sand-mill equipped with a pair of the improved wheels illustrated.

Over a generation ago attempts were made to eliminate the troubles enumerated above, and a wheel was designed of the notched type, but it remained essentially a roller, with less surface area, and gave the same results as a narrow roller. As distinct from rollers it will be seen from the illustration that the wheels have large cogs or teeth, having flat faces, the action being very similar to the old hand method of cutting and pressing sand on the bench.

The first motion of each cog is a cut to the bottom of the pan, then the flat face of the cog presses the sand (which is not a great depth under the tooth), and then the sand is cut again by the other edge of the cogs.

The track of the rollers is increased in diameter or decreased by setting the wheels farther apart or nearer together, as the case may be. In this manner the wheels are operating automatically on different portions of sand each revolution. The scrapers give no trouble, the belt remains efficient, and the sand comes out at the discharge in a satisfactory condition. The design is the outcome of years of belt troubles, caked-sand, various types of scrapers, notched rollers, unsightly castings, attempts to cut the red-sand bill, and the necessity for tough and open sand.

Institution of British Foundrymen.

SHEFFIELD BRANCH.

The Mechanical Properties of Metals.

At the sixth meeting of the session Mr. F. C. A. H. Lantsbury, M.Sc., F.I.C., gave a lecture on "The Mechanical Properties of Metals." This was a joint meeting with the Society of Engineers and Metallurgists and the Institute of Metals.

Dealing first with mechanical tests, MR. LANTSBURY said this was the group of tests which was of the greatest interest to mechanical engineers, because, after all, the utility of all engineering structures was dependent almost wholly on their abilities to resist the action of stress. All engineers were familiar with the operations of making simple mechanical tests in tension, torsion, shear, compression and bending, with the object of obtaining values for the breakdown strengths and ductilities under these types of stress. The first point was the method involved in weighing the forces used in testing. Generally, this was effected by means of a jockey weight, which could be caused to move along the graduated lever of a steelyard, which lever might be simple or compound. This method of measurement was subject to a disadvantage which might give rise to serious discrepancies in the results obtained as a result of the inertia of the jockey weight. There was a very grave danger indeed that this defect might set up momentarily stresses in the test specimen which were greatly in excess of those recorded in the machine and give rise to results which were entirely misleading. This danger could be entirely eliminated by taking advantage of the hydraulic method of weighing largely developed by Martens. English testing machine makers had not taken the advantage they might have of this method of load measurement, but the Emery machine (U.S.A.) and the Amsler (Swiss) machine were excellent examples of the use of this principle.

For comparison it was important to use geometrically similar test pieces and conform to British standard specifications. The second point in the making of static tests was the extreme importance of true axial loading. A slight degree of eccentricity in loading was sufficient to give erroneous results, and this was particularly liable to occur during the use of wedge grips. Endeavours were made to obviate or minimise this trouble by the use of spherically seated grips, but even this precaution was not wholly sufficient to eliminate entirely the trouble. Quite early in the history of mechanical testing it was discovered that in actual use metals ultimately broke under stresses far lower than the maximum stress determined by the simple tensile test. This was first proved experimentally by the English engineer Fairburn, and his work was extended by the experiments of the German investigator Wöhler, whose results were published in 1871. As a result of this work it became generally recognised that neither the maximum stress nor the yield stress were any guide to the life of a material under repeated stresses. The object of his lecture was rather to consider results in a general way than to give details of the actual test. But reference to some of the outstanding tests must be made in order to get an adequate idea of results. Wöhler's test consisted in gripping the specimen in a rotating chuck suspending a weight from the free end.

The specimen was thus subjected to alternate bending stresses, the determination of which was a matter of simple calculation. The results were expressed as number of alternations to produce fracture under the outside fibre stresses involved. Although this was the oldest of the dynamic stress tests, it was still one of the simplest and best. As ordinarily carried out, it suffered from the defect that after the test had been running for some time the freely suspended weight acquired a certain periodicity of up-and-down movement, which made the fibre stresses of uncertain quantity. This defect could be removed by substituting for the suspended weight a fixture which could bend the specimen by a certain known amount and holding it rigidly in this position. Under these conditions there could be no question of periodicity. One of the objections which had been advanced against the Wöhler test was that in the bending test the maximum stresses existed at the surface of the specimen only. The principle of subjecting specimens to alternating uniformly distributed stresses was introduced by Prof. Osborne Reynolds, and developed by Dr. Stanton at the National Physical Laboratory. A still later machine was that of Prof. Smith, of Belfast, who utilised the centrifugal force of rotating masses to set up the stress in the test piece, and at the same time utilised a powerful spring to alter the stress range. One of the difficulties with regard to the carrying out of alternating stress tests was that although the limits of stress variation were defined there was in the methods described no knowledge as to how the variation occurred between two limits. The difficulty had been successfully surmounted in the arrangement introduced by Haigh. One end of the specimen was fixed to the frame of the machine, while the other end was attached to an armature situated between two electric magnets excited alternately by alternating currents. In this way there was produced in the specimen a stress variation which must follow the sine wave of the E.M.F. of the exciting current.

Although engineers were more or less familiar with the methods of making static tests, they were either ignorant of or showed remarkable contempt for the correct description of the tests. The terms stress and strain were more frequently misused than quoted properly, and before passing on to a consideration of the methods devised for the study of the elastic state of material it was necessary to have a clear conception as to the exact meanings of stress and strain. When a material was subjected to the action of a load or force it was said to be under stress, and stress was measured as load per unit area. The action of stress was to cause or tend to cause deformation or alteration in dimensions, and the alteration in dimensions of unit material was known as the strain. To speak, therefore, of a strain of so many tons or pounds per square inch was absurd.

It was the behaviour of the material in the elastic region which was of the greatest interest to the engineer, because the results of dynamic testing, which had been highly developed during the last few years, had proved conclusively that any stress in excess of the yield stress would ultimately lead to fracture. There was a general notion that the determination of the elastic properties were too difficult for commercial purposes, but since the ordinary commercial tests did not provide sufficient information to the engineer, there was no doubt that in time determinations of elastic constants would have to be made in lieu of the many imitative tests which had been introduced.

Mr. Lantsbury referred to a number of extensometers and the methods of using them, and remarked that in making the ordinary tensile tests all who had had experience of testing had observed that with materials like mild steel there was a distinct drop of the beam when the yield load was attained, whilst with other materials, like copper, no such drop of the beam occurred.

The lecturer referred to a number of tests which he described as obviously of great importance. When the results had been further studied, so that their real physical meanings could be thoroughly understood, they would undoubtedly have a great influence on the future of mechanical testing. At present the results obtained were bringing the tensile test to their notice, and only when they were thoroughly understood would the full value of this test be realised. If a specimen was stressed beyond its yield point and the stress removed they knew that one of the effects was permanent deformation, but another and more interesting effect had been produced. On immediate reloading, observations with the extensometer showed that the material began to yield immediately. In other words, its elastic limit was zero. But if the specimen was kept for a period of 24 hours or heated in boiling water for half an hour before re-testing, it was found that the elastic limit was raised to a point only just below the stress to which the material had previously been subjected. This process could be repeated

until the elastic limit was practically coincident with the maximum stress of the material. The effect of mechanical work in "improving" the mechanical properties of a metal were, of course, well known in practice, and was made use of in the operation of cold rolling. They saw, therefore, that the determination of the elastic limit of a material was extremely liable to give misleading results if their object was to get an idea of the true properties of the material itself. Proceeding further with the inquiry, it was found that a specimen which had had its elastic limit in compression lowered. Similarly, compressive increased by tensile work had had its elastic limit work increased the elastic limit in compression and at the same time lowered the tensile elastic limit, and in every case the decrease in one value was equal to the increase in the other value. Or, in other words, the range of stress over which a material behaved elastically was constant for that particular material. Now the limiting range of stress for which a material would resist an infinite number of reversals was independent of small variations of the mean stress, and Stanton and Bairstow had shown that the true or natural elastic limit of a metal was equal to half the limiting range of stress, while the very essence of Bauschinger's theory of breakdown was that in its natural state the compression and tensile elastic limits of a metal were equal in value. The value of the elastic limit determined in the ordinary way had been callel the "primitive" elastic limit to distinguish it from the "natural" elastic limit determined by alternating stress tests. It would be observed that in every case the true elastic limits were lower than those determined by the ordinary static method, and this was, of course, of the utmost value to the designer.

But there was still a great deal of knowledge to be gained with regard to endurance tests, and in view of the enormous amount of time necessary for obtaining the results endeavours had been made to find the limiting ranges in shorter time. The subject of hardness testing was one of extreme importance to the engineer, and yet it was of great difficulty, because of the confusion of ideas which existed as to the meaning of hardness. The mineralogical definition of hardness was resistance to abrasion, but even this is not a single property, but a combination of a number of properties. Therein lay the difficulty with regard to the subject of hardness, in that up to the present time the methods which had been introduced did not measure any particular property but a combination of properties, and the influence of each of the properties was different in each test. Nevertheless, the methods which had been introduced had undoubtedly been of great practical value in enabling the metallurgist and engineer to get greater uniformity of product. His work led him strongly to believe that there was a definite property of metal which would ultimately be recognised as true hardness. At the present time, however, the whole of their ideas on this subject were in the melting pot, and the work and discussions going on at the present time would consolidate and focus their ideas on the subject. At the present time three methods were in vogue for testing hardness, the method chosen depending upon the material to be tested and the knowledge required. These methods might be described as (1) scratch tests, (2) penetration tests, (3) abrasion or wearing tests.

So far, said Mr. Lantsbury, in conclusion, purely physical tests did not interest the mechanical engineer so much as the electrical engineer, but there were indications that in the very near future magnetic testing would be used very largely in testing, because there was undoubtedy a close relationship between the magnetic and mechanical properties of steels. There never was a time when the testing of metals was of such great importance to the engineering industry, and an adequate system of testing would only be realised by thorough discussion of the available methods and their indications by the engineer and physical metallurgists.

DISCUSSION.

MR. TURNER thanked Mr. Lantsbury for his lecture, and said that when they saw all the thought and energy that had been expended upon testing machines they realised that there was a good deal more than they thought in the production of models for ordinary serviceable use.

MR. J. R. HYDE remarked that Mr. Lantsbury had offered a very clear explanation of many of the terms and machines of which they read and heard, but with which, in the foundryman's business, they did not actually get in touch. They could quite imagine that when engineers had tried most methods of testing steel and non-ferrous castings and found them wanting, they might turn to some of these more elaborate machines and see if they would help them still further. They laboured under a great disadvantage, for when they had cast their mould nobody seemed to have very much confidence in it, and it would be by careful investigation and with the clear guidance of such gentlemen as Mr. Lantsbury that they would possibly be enabled to improve their product. The many workers he had mentioned did not, of course, include all of them, because they had seen from time to time in Sheffield other machines to which Mr. Lantsbury had not referred. He would like to know whether the ones mentioned represented the most reliable and what might be called the standard machines of 1922. He was much more familiar with these things 10 years ago, and many that he knew then seemed to have entirely disappeared. Mr. Hyde went on to say that he was very much indebted for the stress-strain diagram and the description of the two terms. It was surprising how indistinct many of the leading chemists were when they were using the words stress and strain. Sometimes it seemed as though every man was a law unto himself, and until one got used to him it was extremely difficult to understand what he really meant.

MR. J. WATSON said the lecture had been particularly interesting to men like himself who were engaged in the foundry. They saw the test piece cut off from the casting, and knew nothing about it until they got the report. Very often they never saw the machines that broke it or the test piece afterwards.

A resolution of thanks was accorded Mr. Lantsbury for his lecture.

WEST RIDING OF YORK BRANCH.
FIRST ANNUAL MEETING.

The first annual meeting of this branch was held on April 8 at the Bradford Technical College.

The Branch-President, Mr. A. A. Liardet, was in the chair. The secretary, Mr. T. Johnson, submitted a short report of the activities of the branch since its inauguration, and submitted the accounts. Mr. W. H. Poole submitted a report on the Standard Testbar Committee held at Manchester on March 25, and outlined the steps which were to be taken by the various branches to enable the delegates to submit the branches' views on the subject at a forthcoming general council meeting. Some discussion followed, and it was decided to hold a meeting at an early date so that the subject might be discussed and the delegates instructed as to what recommendation to put forward.

The election of officers for 1922-1923 session then took place. The whole of the present council was re-elected, except the honorary secretary, Mr. T. Johnson, who resigned, Mr. A. Love, of Bradford, being elected to fill the vacancy.

The Branch-President then read his address, taking for his subject "The Training of Foundrymen," and outlined a scheme of training for apprentices in foundries in connection with local technical institutions, so that boys being apprenticed in foundries either to moulding or coremaking should have opportunites of gaining a knowledge of the higher branches of foundry work before the actual completion of apprenticeship. A diagram was handed to each of the members showing the suggested training detailing the subjects on which instructions would be given.

The paper was followed by a lively discussion, in which most of the members and several of the visitors took part, and finally a resolution was unanimously passed that the scheme should be placed before iron-foundry employers in the district covered by the branch, with a strong recommendation from the meeting that the scheme as put forward, or in some modified form, should

have the serious consideration of all foundry owners. It was the opinion of the meeting that such a scheme would go a long way to remove the present difficulty of finding boys willing to be apprenticed to moulding and would generally improve the status of the foundry craftsmen of the future.

The meeting closed with a vote of thanks to the chairman.

BIRMINGHAM BRANCH.

Discussion on Mr. Whyte's Paper on Brass Foundry "Imp—Ology."*

THE BRANCH-PRESIDENT said he was particularly interested in Mr. Whyte's remarks as to faulty castings being attributable to bad copper, and he would like to know how Mr. Whyte came to the conclusion that the copper he used was faulty. Was he going by its physical nature? Probably that was not the case, or he would have found that the copper was bad before he used it. As to the question of downgates, he said that a considerable amount of correspondence and experiment on the subject was going on at the present time, particularly with reference to iron. There were a number of founders in this country who, having read and seen what was done at the foundries of Messrs. Ronceray et Bonvillain at Paris, were themselves experimenting with a reduction of downgates and runners. He thought very often the solution to foundry trouble lay not in increasing the size of gates and risers but in their decrease. But it was a fact that at Messrs. Ronceray's foundries they cast up to 7 and 8 cwt. and ran with only one downgate, and that only about five-eighths of an inch in diameter. He was also very much interested in Mr. Whyte's references to the effect of small quantities of impurities, and he thought that when students were learning about the elements found in iron and non-ferrous metals it would be an advantage if those elements were not introduced as elements but as the compounds in which they existed in the metal.

PROFESSOR T. TURNER, in proposing a vote of thanks to the lecturer, said Mr. Whyte had been both practical and humorous, and was an illustration of the old saying that there is many a true word spoken in jest. Mr. Whyte had spoken of the imps of the brassfoundry, and, of course, he was referring to certain natural laws which were in operation in the foundry—laws of combination, solution, expansion, and so forth. He did not think we need consider that there were any evil laws in nature. They were all beneficial. It was only a question of ascertaining how they acted, and how they could be employed to advantage. He suggested that these imps, by proper management, could be converted into beneficent fairies. With reference to oxygen in copper, it was known that it had a very grave and injurious effect when present in the form of cuprous oxide beyond a very limited amount; but in brass the amount of oxygen that remained must be very small, because the zinc present combined readily with the oxygen and formed a scum, which was removed. It was not very easy by analysis to ascertain how much oxygen was left, but they knew it was very small. He spent some time in endeavouring to determine the amount of oxygen in brass without any considerable measure of success, but Professor Carpenter and one of his assistants introduced a method which gave results, but the analytical process was somewhat troublesome. With reference to the solubility of gases in copper and copper alloys, solubility increased as temperature rose. Gases left in solution in any large quantity tended to produce brittleness, and to cause the metal to be low in elongation. It was extremely important to pour the metal at the right temperature if they were to get the best results—free from gases and with the highest tensile strength.

The vote of thanks was seconded by Mr. W. J. Flavell, and passed with cordiality.

MR. D. WILKINSON said if a casting could be so arranged that the feeders fed it without the introduction of a rod he had always found that method far more satisfactory than if a rod was introduced. The only trouble was that to feed a casting without putting in a rod meant that the feeder had to be considerably larger, involving more trouble in removing it and greater waste of metal. But in a very important casting it was better to make sure of success even at more expense. He was very interested in Mr. Field's remarks regarding Messrs. Ronceray's castings. More than twenty years ago he made a series of castings 25 cwts. each and these were cast with a small gate, of which the inlet measured $1\frac{1}{4}$ in. × $\frac{5}{8}$ in. All the metal passed through that. It was exactly the same type of runner as Messrs. Ronceray showed in the diagrams printed in THE FOUNDRY TRADE JOURNAL, and it had been used in some parts of England fifty to sixty years ago. As to chills, he remarked that frequently the troubles one overcame by the use of chill were only removed at the expense of other troubles which the chill brought in its train.

Replying upon the discussion, MR. WHYTE said that as to the question of the selection of copper and how they arrived at the best brands, it was simply by trial and error. All the commercial brands, three of the principal brands at any rate, on analysis were pretty well alike. Mr. Whyte afterwards illustrated on the blackboard the methods employed in the casting of propellers.

* This paper appeared in the April 27 issue of the FOUNDRY TRADE JOURNAL.

Plastic Wood.

There has recently been placed upon the market by Messrs. Necol Industrial Collodians, Limited, of 62, London Wall, London, E.C.2, and Stowmarket, a novel material adequately described as plastic wood, which should find infinite use in the pattern shop. The material has for its base, cellulose or woody tissue. This base has been treated with nitric acid, from the excess of which it has been freed, and spirits, the principal one of which is amyl acetate. The nitrated cellulose is then incorporated with finely-ground wood meal.

Plastic wood is marketed in air-tight canisters, and the first obvious application which would suggest itself to the foundryman is the ease with which fillets can be inserted in the corners of patterns. The material takes some two hours to dry, and gives a smooth, hard surface, which can be varnished or machined like wood; it is, however, slightly harder than most. Its application is not confined to wood patterns, as it is equally suitable for cast iron or any other metal.

Plastic wood will be found extremely useful for altering patterns or for adding more taper, when the patternmaker has not been too lenient.

If the claim of the manufacturers that plastic wood is waterproof can be sustained, then from experiments we have made it should find an excellent field as an improved substitute for glue.

When dry it will hold nails or tacks, and the manufacturers claim that in addition to being waterproof, it is also grease- and climate-proof.

A practical application which recently came before our notice was the case of a conveyor gear wheel, which had stripped a tooth. If normal procedure had been followed the machine would have been out of action for probably a week, but by modelling a new tooth with plastic wood, and by using the broken wheel as a pattern, a new gear was supplied the same afternoon.

Worn bearings can be plastered with a thin layer of plastic wood so as to reproduce their original dimensions, in order that they can be used as patterns.

Test pieces made from this material are claimed by the manufacturers to have the same tensile strength as most woods, and a higher transverse test, owing to the absence of grain.

In making large sections it is suggested that the material should be built up in layers, each layer being allowed to dry before being added to.

The contraction of plastic wood has been found to be three per cent.

The manufacturers supply a cleaning fluid for the purpose of re-conditioning aged material and the cleaning of the hands after handling the material.

THE INSTITUTION OF AUTOMOBILE ENGINEERS AND THE MUNICIPAL ELECTRICAL ASSOCIATION have planned to hold conferences in Birmingham during the period of the Intimation Foundry Trades' Exhibition.

Trade Talk.

THE IMPORTS OF FOREIGN IRON ORE at the Senhouse Dock at Maryport last week amounted to 3,500 tons.

MESSRS. J. AND A. MCMORLAND have removed from 33a, Gordon St., Glasgow, to 40, St. Enoch Sq., Glasgow.

THE SUPERHEAT FURNACE COMPANY, LIMITED, have removed from 21, Morley Street to 16, Adolphus Street, Bradford.

THE SWANSEA HARBOUR TRUSTEES have granted Palmers Shipbuilding & Iron Company, Limited, of Jarrow, a further lease of land for their dry docks at Swansea.

A DESTRUCTIVE fire broke out on April 22 at the Gowanbank Iron Works, Falkirk, belonging to M. Cockburn & Company, Limited, considerable damage being done to the electrical department.

CONSIDERABLE DAMAGE resulted from a fire which occurred at the works of William Thompson & Company, sheet metal manufacturers and brassfounders, Ludgate Hill, Birmingham. The outbreak was confined to the second floor.

THE SOCIETE ANONYME DES ETABLISSMENTS, Ph. Bonvillain & E. Ronceray, of Choisy-le-Roi, near Paris, announce that during 1921 they shipped to Great Britain moulding machines and appliances to the amount of 805,000 francs, for actual orders and not for stock.

THE CONTRACT, of an approximate value of £70,000, for the supply and installation of pumping machinery at Atf, in Lower Egypt, has been secured by the Associated British Manufacturers. There was keen competition on the part of Swiss, German, French, Dutch and other firms.

MR. T. MADSEN read a paper before the members of the North-East Coast Institution of Engineers and Shipbuilders in Newcastle, on April 21, on "The Running Costs of Diesel-Engined Ships." Mr. Madsen is the superintendent engineer of the Swedish Transatlantic Steamship Company.

MR. G. MANN was re-elected president of the Leeds Association of Engineers at the annual meeting on April 20. Mr. T. H. Goldsack was again elected as vice-president, Mr. W. Rainforth as treasurer, and Mr. W. Chisholm librarian. Messrs. G. R. Goldsack, C. Porter, F. C. Bettison, and T. Cooke were elected on the council.

THE ascertainment of the average net selling price of manufactured iron (rounds, squares, flats, tees, angles, hoops and rods) in the West of Scotland has been returned as 255s. 7d. per ton for the first two months of the year. This is a decrease of 29s. 6½d. on the previous two months, and of 300s. 11d. on the corresponding period of a year ago.

LICENCES under the Non-Ferrous Metal Industry Act, 1918, have been granted to Anderson Proud and Co., Suffolk House, Laurence Pountney Hill, London, E.C.4; Etchells, Harry, Boston Works, Mary St., Sheffield; Full and Co., H., 29, Vauxhall St., Plymouth; Ironside, Son and Co., 39, Grosvenor Pl., London, S.W.1; and Wilson, Robert, 16, Blythswood Sq., Glasgow.

THE STAFFORDSHIRE EDUCATION COMMITTEE are offering two scholarships each in mining, metallurgy and engineering of the annual value of £50, together with a maintenance allowance not exceeding £50 in cases of necessity, tenable at the University of Birmingham. One scholarship of each class will be allocated to North and one to South Staffordshire, provided suitable candidates offer themselves.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED, have for some months been experimenting with the packing of coils of V.I.R. wire in cartons and containers of strong fibreboard, and they now announce that all qualities, in sizes 1/.044 in. (0.0015 sq. in.) and 3/.029 in. (0.002 sq. in.), will be delivered in this improved manner in future. It will be extended to other sizes subsequently, and as soon as arrangements can be made.

A JOINT conference took place in London last week between the Negotiating Committee of the shipyard trade unions and the committee of the Shipbuilding Employers' Federation. At the conclusion of the conference, the following agreed official statement was made by Mr. Belch for the employers and Mr. Purdy for the unions:—Proposals have been discussed with a view to a settlement, and both parties are reporting to their constituents.

AMONG RECENT CONTRACTS received by Gallagher & Crompton, of Salford, Manchester, for the installation of patent baffle bridges there is one from the Newcastle Corporation Transport and Electricity Undertaking, to equip seven Lancashire boilers with the appliance at their Manors Power Station. This is a repeat order following a trial order placed a few months ago. Other contracts have been received from Sir B. Samuelson & Company, Limited, the Gas Light and Coke Company, London, the Commercial Gas Company, and Ramsgate Corporation, etc.

ARRANGEMENTS HAVE BEEN MADE for the manufacture of the Monometer furnaces for the whole of the United States, Canada and South America by the Monarch Engineering and Manufacturing Company, 1206, American Building, Baltimore, U.S.A. These furnaces are already being manufactured by a company in France, and arrangements are also being made for their manufacture in Berlin, for the supplying of the northern territories, including Russia, and the Czecho-Slovakia State.

AT the annual meeting in Manchester, on April 25, of the North-western Centre of the Institution of Electrical Engineers, Mr. J. W. Beauchamp spoke on engineering advertising and the work of the British Electrical Development Association. The committee's report announced an increase in the number of members, the total being 1,343, against 1,214 in the previous year and 984 in 1919-20. Mr. A. S. Barnard was elected chairman of the centre, and Mr. W. A. Coates became the hon. secretary.

A CONFERENCE on industrial welfare work and canteen organisation was held in the Manchester Town Hall recently. It had been convened by the Manchester Industrial Welfare Society. Mr. W. Melland, who presided, said that although there was a humanitarian aspect of the work it was becoming recognised by employers that it was also good business. It was of the greatest importance in these days of increased leisure that that leisure should be wisely spent. He believed that the provision of increased opportunities for recreation for people in their leisure hours would result in great savings on hospitals, industrial schools, and prisons.

THE final meeting of the seventeenth session of the Wolverhampton and District Engineering Society was held recently, under the chairmanship of the president (Sir Walter H. Evans). The meeting was devoted to a discussion on a paper read before the society some time ago by Mr. W. Stevenson, of Birmingham, on power production in the Staffordshire district. Mr Stevenson had dealt specially with the value of the gas engine; and further papers were contributed by Mr. J. Barker (of Stockport), who argued in favour of the Diesel engines; by Mr. A. T. Smith, of Stoke-on-Trent, for the steam turbines; and by Mr. T. Smith, Wolverhampton, for electricity.

THE QUARTERLY MEETING OF THE GRAND COUNCIL of the Federation of British Industries took place in London last week, Sir William Peat in the chair. A report was submitted of the steps taken by the Federation of British Industries to secure a reduction of taxation in the forthcoming Budget. The Director of the Federation of British Industries, Mr. R. T. Nugent, was instructed to send a letter to the Chancellor of the Exchequer, in which the Federation reaffirms the demand it put forward to the Chancellor of the Exchequer on February 15 last for a reduction in the rate of income tax of 2s. in the £, the abolition of the Corporation Profits Tax, and a corresponding adjustment of taxation in respect of the businesses of private firms.

AN electric locomotive for hauling a standard express East Coast passenger train at an average speed of over 65 miles per hour, is being built at the North-Eastern Railway locomotive works at Stoopersdale, Darlington. The engine has been designed by Sir Vincent Raven, in connection with the proposed electrification of the main lines from York to Newcastle. The electrical equipment is being provided by the Metropolitan-Vickers Company. The wheel arrangement is of the 4-6-4 type. The main frame is connected to the three driving axles, while there is a four-wheeled bogie at each end. The driving wheels are of 6 ft. 8 in. dia. The cab is attached to the main frames, and there are sloping ends over the bogies, one containing the high tension apparatus and the other the electric boiler for steam for train heating. The capacity of the locomotive will be 1,800 horse power one hour rating, or 1,260 h.p. continuous rating; in other words, allowing a temporary "overload" of 50 per cent. The rigid wheel base of the locomotive is 16 ft.; the length from the centre of the bogies 37 ft. 2 in., and the length over buffers 53 ft. 6 in. The total estimated weight is 102 tons.

Gazette.

IN the Companies (Winding-Up) Court the petition of Bagshawe & Company and another for the compulsory winding-up of W. S. Laycock, Limited, was again adjourned for a month.

MESSRS. A. C. MILLER and L. E. Snapes, welding and sheet metal workers, 10, Devons Road, Bow, trading under the style of the Bow Welding & Sheet Metal Company, have dissolved partnership.

THE LAST DAY for receiving proofs in connection with a dividend to be paid by Mr. J. Burke, lately carrying on business under the style of Burke & Culey at 8, Malt Street, Hulme, Manchester, steel and engineers' tool merchant, is May 5.

Czecho-Slovak Ironworks.

The report of the directors of the Poldi Hütte, of Prague, for 1921, states that the economic crisis had at the date of the report extended to almost the whole of the Company's markets, so that the orders coming to hand at present are insufficient to keep the works fully occupied. The net profits realised last year amounted to 10,800,000 Czech crowns, as against 12,420,000 (£517,500 at par) in 1920, and it is intended to pay a dividend at the rate of 8 per cent. on the share capital of 125,000,000 crowns (£5,208,333), as compared with 10 per cent. on 100,000,000 crowns in 1920.

The management of the Prague Iron Industry Company have issued a statement announcing that operations in the second half of 1921 resulted in a considerable loss. This is attributed to the financial, social and other measures adopted by the Government, including their tariff-policy, which prevent the Company from adapting the costs of production to the situation in the world's iron and steel markets. The financial burdens totalled 193,000,000 crowns (over £8,000,000 at par) in 1921, or over 1,000 crowns per ton of rolled products. As a consequence, selling facilities were restricted, and the production had to be reduced. Sales resulted in a loss, and orders were only accepted to keep the works going on short time. The situation became worse with the fall of the mark and the rise in the value of the Czech crown. Under these circumstances it had been found necessary to discharge 22 per cent. of the workmen and officials, and further dismissals have been made since. The last blast furnace had to be blown out. In conclusion, the management express the opinion that it will be impossible for the iron and steel industry to continue to exist unless a radical change takes place in the economic policy of the Government. (Present rate of exchange 220 crowns to the £.)

Personal.

MR. ARTHUR CAWWOOD, of George Cawwood & Son, Westgate Foundry, Rotherham, died on April 16, in his sixty-first year.

THE LATE MR. ALEXANDER MCGEOGH, of Melrose, Sherbourne Road, Acock's Green, brassfounder, left estate valued at £37,631.

THE LATE MR. F. T. SHAW, J.P., a partner in W. Shaw & Company, steel founders, Middlesbrough, left estate of the gross value of £51,983.

MR. J. E. SHAW, iron and steel manufacturer, Old Hill, Staffs., has been re-elected chairman of the Rowley Regis Urban District Council.

MR. C. H. PINSON, lock manufacturer, of Willenhall, has been re-elected chairman of the Willenhall Urban District Council for the fourth year in succession.

MR. P. ROBSON, of Clayton & Shuttleworth, Limited, has been appointed by the Federation of British Industries to attend the Genoa Conference in the capacity of expert on agricultural machinery.

MR. J. EDWARDS, of Albion Villa, Roby, near Liverpool, joint managing director of Higson, Edwards & Company, Limited, iron, steel and tinplate merchants, Liverpool, who died on February 12, has left £6,890 gross and £6,511 net.

LIEUT.-COLONEL C. F. HITCHINS, D.S.O., M.I.Mec.E., who recently resigned the appointment of general manager to Agricultural and General Engineers, Limited, has joined Sir W. G. Armstrong, Whitworth & Company, Limited.

MR. H. ELLENS OVING, JR., chairman of the British Steel & Iron Exporters, Limited, London, celebrated his 70th anniversary on April 19, when Mr. W. Ridley Makepeace represented the British company at the birthday celebrations in The Hague.

MR. T. W. HODGES celebrated, on April 26, the 50th anniversary of his connection with the Consett Iron Company, Limited, of which he is the Newcastle agent. Mr. Hodges is a nephew of the late Mr. William Jenkins, for many years general manager and some time a director of the company.

SIR HENRY HOLLINGDRAKE, of Messrs. Henry Hollingdrake & Son, of Stockport, engineers and ironfounders, and Messrs. Osman Shaw and Rupert T. Cooke, both directors of Messrs. Francis Shaw & Company, Limited, Manchester, manufacturers of rubber machinery, were present at the dinner held in New York to welcome Messrs. Stubbs and Frith, the delegates of the Institution to the United States.

Company News.

Richards Brothers (Darlaston), Limited. — Capital £5,000 in £1 shares. Ironfounders and engineers, etc. Registered office: Phœnix Works, Bell Street, Darlaston.

K. A. R. Products, Limited.— Capital £100 in £1 shares. Engineers. Director: A. R. Kearnley. Registered office: 6, Templars Avenue, Golders Green, N.W.

Plant & Supplies, Limited.—Capital £4,000. Electrical and mechanical engineers, etc. Director: A. P. Pope. Registered office: 12 and 13, Henrietta Street, W.C.2.

Pease & Partners, Limited.—Final ordinary dividend, 3 per cent., free of tax, making 5 per cent.; distribution entailed drawing upon reserve for equalisation of dividends.

J. Shewell & Company's Successors, Limited. — Capital £16,000 in £1 shares. Engineers. Directors: E. L. Pease and E. H. Pease. Registered office: Albert Hill, Darlington.

James Gordon & Company, Limited.—Capital £15,000 in 8,000 7½ per cent. preference shares of £1 and 14,000 ordinary of 10s. Engineers. Registered office: Windsor House, Kingsway, W.C.

Harold Hudson, Limited.—Capital £15,000. Engineers, etc. Permanent directors: H. Hudson, E. B. Fairburn and J. A. T. Crowther. Registered office: Brewery Yard, Hunslet Wood, Leeds.

Macdonald Brown, Limited.—Capital £250 in £1 shares. Engineers. Directors: H. Holt and F. T. Warne. Secretary: H. C. Munday. Registered office: 39, Furnival Street, Holborn, E.C.4.

William Stein & Company, Limited.—Capital £2,000 in £1 shares. Engineers. Directors: W. Stein, T. W. Turnbull, J. Turnbull, and A. Turnbull. Registered office: 9, St. Bernard's Row, Edinburgh.

France & Morgan, Limited.—Capital £20,000 in £1 shares. Brassfounders. Directors: R. Morgan and A. Morgan. Registered office: Whitefield Brass Works, 44, Carmichael Street, Govan, Glasgow.

West of England Mines & Metals, Limited.—Capital £1,000 in £1 shares. Directors: W. D. Williams, J. E. Brunt, and J. A. Roberts. Secretary: H. C. Wintle. Registered office: 30, Baldwin Street, Bristol.

J. B. Bower & Company, Limited.—Capital £10,000 in £1 shares. Electric apparatus manufacturers. Directors: J. P. Wallis, J. P. Bower, and O. O. Dale. Registered office: 15, Kingston Road, Wimbledon, S.W.

Welsh Steel Supply & Construction Company, Limited.—Capital £2,000 in £1 shares. Directors: J. B. Dawson and R. Watkins. Registered office: Albert Hall Chambers 13, Craddock Street, Swansea.

Swan, Hunter & Wigham-Richardson, Limited.—Profit, £415,398; brought forward, £53,882; disposable balance, £454,000; final ordinary dividend, making 8 per cent. for year; reserve, £210,000; carry forward, £53,000.

Evans Metal Workers, Limited.—Capital £1,500 in £1 shares. Directors: W. A. Evans, A. Redford, J. H. M. Evans, and C. Pickstone. Secretary: A. Redford. Registered office: 45-7, Adeline Street, Cheetham, Manchester.

Catalogues Received.

PENMAN & COMPANY, LIMITED, Caledonian Iron Works, Glasgow.—"Foundry Ladles."

WAYGOOD-OTIS, LIMITED, 54 and 55, Fetter Lane, London, E.C.4.—Catalogue of electric lifts.

C. H. W. MITCHELL & COMPANY, 142, West Regent Street, Glasgow.—"Wallace Bench Machines."

FREDK. BRABY & COMPANY, LIMITED, Petershall Road, Glasgow.—"Braby's Handbook for Architects and Engineers."

"COAN'S ORIGINAL CAST ALUMINIUM NUMBER PLATES."—Robert W. Coan, 219, Goswell Road, London, E.C.1.

"INGOT HANDLING MACHINES."—The Wellman Smith Owen Engineering Corporation, Limited, 36 and 38, Kingsway, London, W.C.2.

THE MIDLAND MOTOR CYLINDER COMPANY, LIMITED, Dartmouth Road Foundries, Smethwick.—"What America Thinks of Midland Cylinders."

THE BRITISH ALUMINIUM COMPANY, LIMITED, 109, Queen Victoria Street, London, E.C.4.—Folder and card dealing with distinctive furnishings in aluminium.

THE STAVELEY COAL AND IRON COMPANY, LIMITED, Chesterfield, forward their monthly list of cast-iron pipes for water, gas, steam, drainage, hydraulic and other purposes.

IRON AND STEEL MARKETS.

Pig-iron.

The uncertainty of the industrial position continues an adverse influence on buying in the pig-iron markets, which remain in a state of suspended animation as far as the home trade is concerned. It is, however, somewhat remarkable in the circumstances that a steady tone is maintained, South Staffordshire reporting a rather more confident feeling of an early revival of demand, although it is difficult to surmise the grounds on which this conclusion is based. At Birmingham, last week, the demand for forge pig was again poor, with most of the finishing mills idle, while movements in foundry qualities were still confined within very narrow limits. In Scotland, also, the pig-iron market continues dull and depressed, many of the iron foundries being idle, and consumption by steel makers on an unusually limited scale. At the weekly meeting of the Glasgow Iron Ring there were sellers of No. 3 Middlesbrough at 90s., mixed numbers Middlesbrough hematite at 97s. 6d., No. 3 Scotch at 97s. 6d. and No. 3 Scotch warrants at 98s. 6d. a month, but no business was done. At Middlesbrough many consumers are reported to have suspended deliveries owing to the lock-out, and were it not for the foreign demand some of the local blast furnaces would have had to go out of operation, for ironmasters can ill afford in these days to make iron for stock. Fortunately, heavy shipments are still being made to the Continent, and there is quite a fair business being done. Germany continues to buy Cleveland iron, and a few quite small parcels are still being sold to Italy, but for the Belgian trade there is very keen competition, and generally the demand is scarcely so brisk as it has been. To Scottish consumers No. 3 G.M.B. is now quoted 100s. per ton, f.o.t. Grangemouth, but to all other destinations the uniform quotations, f.o.t. or f.o.b. at the Tees, are : No. 1 and silicious, 95s. ; No. 3 G.M.B., 90s. ; No. 4 foundry, 87s. 6d. ; No. 4 forge, 85s. ; mottled and white, 80s per ton.

While there is no very marked change in the East Coast hematite position, there is no improving tendency to be noted. The home trade has slackened off, owing to the troubles in the engineering and shipbuilding industries, and recent concessions have probably tempted buyers to keep out of the market in the hope of even lower terms. Quotations for East Coast mixed numbers do not tend to fall below about 96s. per ton, and in some cases makers will not look at anything less than 98s. The No. 1 quality is at a premium of 1s. per ton.

Finished Iron.

Business generally has now been resumed in the various departments concerned in the manufacture of finished iron products, and, while there is still a good many plants idle, there is a more hopeful feeling expressed that a partial, if not a full recovery of the trade may be imminent in the near future. So far, however, the much-needed revival of demand for finished material has not materialised, while in South Staffordshire competition in the home trade for any orders current is exceedingly keen. This is chiefly confined to the market for common iron bars for nut and bolt and fencing purposes, for which the normal quotations rule at £10 5s. and £10 7s. 6d. respectively. Crown bars also are only in moderate demand, with similar conditions applying in the case of shipbuilding material, orders for which are much prejudiced by the high transport charges for deliveries to the centres of that industry. The recent revision of railway freight rates has done comparatively little to lighten the burden of manufacturers, and until more drastic cuts can be effected in this direction works will continue on diminished output conditions, with consequent unemployment all round.

Steel.

The complete disorganisation of the engineering and allied industries by the protracted dispute has further restricted activity in the steel trade, and unless a speedy settlement can be arrived at must have a serious effect upon business in general, both in the home and export markets. The present position in the industry is the more regrettable from the fact that of late there has been a substantial improvement in inquiries for export, orders recently placed with Sheffield steel manufacturers having been more satisfactory than for a long time past, while reports are current that some large railway contracts for material of various sorts are only awaiting favourable labour develpments to be immediately put in hand. With regard to the recent announcement that the Indian Government was coming into the market for a large quantity of railway steel it now appears that these contracts are to be subject to open competition by foreign and home manufacturers alike, giving due consideration to quality and delivery as well as prices. In this connection it may also be remembered that in India itself recent remarkable developments in the steel trade may have to be taken into account, although it is exceedingly improbable that native works are as yet in a position to compete on favourable terms with British manufacturing plants. During the past week a reduction of 10s. per ton in the price of hard and medium billets brought the price at Middlesbrough down to £8 15s. and £8 5s. per ton respectively, but soft billets are rather dearer at £7 15s. These changes in semi-steel have not affected the price of manufactured steel, and the associated price list is firmly adhered to, although business is extremely quiet.

Scrap.

With the exception, perhaps, of South Wales, where demand is fairly active, there have been few movements to report in connection with the scrap metal trade, very little of this material now coming into the market as a result of the suspension of the engineering industries. This condition applies more especially to turnings and borings, for which in the Midlands prices are distinctly firmer, merchants having little difficulty in realising 35s. to 38s. for steel turnings, and 30s. to 32s. 6d. for cast-iron borings. Quotations are also firmer for heavy steel scrap in that district, while wrought-iron scrap is, on the contrary, weaker than has been the case for some weeks, so many of the forges not having reopened since the holidays.

Tinplates.

The improved demand recently noted for tinplates is well maintained, but business, on the whole, owing to holiday interruption, has been somewhat quieter, with buyers for the home trade still purchasing stock lots, and a fairly active export inquiry. Coke tins in the standard sizes have been done at 19s. 9d. for I.C., 14 by 20, prompt delivery, and 19s. 7½d. for June/July. Current makers' prices run : I.C., 14 by 20, 112 sheets, 108 lbs., 19s. 9d. to 20s. per box; I.C., 28 by 20, 112 sheets, 216 lbs., 39s. 6d. to 40s. 3d. per box, net, f.o.b. Wales. Terneplates are rather slow of sale at the moment. Prices keep steady, however, at round 18s. basis for usual specifications, May/June delivery.

Metals.

Copper.—The market for standard copper during the past week has been remarkably steady on the whole, fluctuations in values having been within narrow limits, and the daily turnover on a fairly substantial scale. Consumptive demand, though still below the normal, is more encouraging in volume on home account, and reports of somewhat similar conditions are current with regard to America, where the termination of the coal strike is expected to lead to a revival of interest in the metal in the buying section. Cash and early May dates were done at the week-end market at £59, but only a small business was passing, with prompt and forward deliveries steady at a shade under the previous values. Closing prices:—Cash : Wednesday, £59 5s. ; Thursday, £59; Friday, £58 17s. 6d. ; Monday, £59 12s. 6d. ; Tuesday, £60 2s. 6d. Three months : Wednesday, £59 17s. 6d. ; Thursday, £59 12s. 6d. ; Friday, £59 10s. ; Monday, £60 5s. ; Tuesday, £60 15s.

Tin.—Movements in the standard tin market last week indicated a reactionary tendency, buying on home consumers' account having declined to some extent, while the Continental demand was much below anticipation. The variations in values were, however, on an unimportant scale, advices from the East giving a small relapse, to which no response was made on this side, and with the American demand reported strong there were fairly substantial dealings on forward account. Mid-May was done at £152 10s. to £153, early June £153 to £153 5s., early July £153 10s. to £154, with Straits tin quoted £155. English ingots were steady at £152 10s. Closing prices : — Cash : Wednesday, £152 10s. ; Thursday, £151 5s. ; Friday, £151 ; Monday, £151 10s. ; Tuesday, £152 5s. Three months : Wednesday, £154 ; Thursday, £152 17s. 6d. ; Friday, £152 10s. ; Monday, £152 17s. 6d. ; Tuesday, £153 15s.

Spelter.—The market for this metal has disclosed little change from its previous steady tendency, but English producers appear to be offering more freely and are quoting competitive prices in South Wales and the Midlands. Some inquiries from the Far East have been in circulation, and some sales have been effected. Closing prices.—Ordinary brands : Wednesday, £27 5s. ; Thursday, £26 15s. ; Friday, £26 17s. 6d. ; Monday, £26 17s. 6d. ; Tuesday, £27 5s.

Lead.—Activity in dealings in soft foreign pig is well maintained, and markets generally have developed further strength. April deliveries were done at £24 12s. 6d., July £23 10s. and £23 12s. 6d., with carrying for three months at 22s. 6d. backwardation. Prices for English lead continue consistently firm with an upward tendency. English closing prices : Wednesday, £25 5s. ; Thursday, £25 5s. ; Friday, £25 10s. ; Monday, £25 ; Tuesday, £25.

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